Calibration and Test Services

of the National Bureau of Standards

United States Department of Commerce

National Bureau of Standards

Miscellaneous Publication 250

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications, including assistance to industry, business, and consumers in the development and acceptance of commercial standards and simplified trade practice recommendations. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. Research projects are also performed for other government agencies when the work relates to and supplements the basic program of the Bureau or when the Bureau's unique competence is required. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

Publications

The results of the Bureau's research are published either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three periodicals available from the Government Printing Office: The Journal of Research, published in four separate sections, presents complete scientific and technical papers; the Technical News Bulletin presents summary and preliminary reports on work in progress; and Central Radio Propagation Laboratory Ionospheric Predictions provides data for determining the best frequencies to use for radio communications throughout the world. There are also seven series of nonperiodical publications: Monographs, Applied Mathematics Series, Handbooks, Miscellaneous Publications, Technical Notes, Commercial Standards, and Simplified Practice Recommendations.

A complete listing of the Bureau's publications can be found in National Bureau of Standards Circular 460, Publications of the National Bureau of Standards, 1901 to June 1947 ($1.25), and the Supplement to National Bureau of Standards Circular 460, July 1947 to June 1957 ($1.50), and Miscellaneous Publication 240, July 1957 to June 1960 (includes Titles of Papers Published in Outside Journals 1950 to 1959) ($2.25); available from the Superintendent of Documents, Government Printing Office, Washington, D.C., 20402.

UNITED STATES DEPARTMENT OF COMMERCE • Luther H. Hodges, *Secretary*
NATIONAL BUREAU OF STANDARDS • A. V. Astin, *Director*

Calibration and Test Services

of the National Bureau of Standards

[Reprinted from the Federal Register
July 26, 1963—Vol. 28, No. 145, Part II,
and November 7, 1963—Vol. 28, No. 218.]

National Bureau of Standards Miscellaneous Publication 250

Issued November 22, 1963

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C., 20402 - Price 70 cents

Library of Congress Catalog Card Number: 63–60099

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Calibration and Test Services of the National Bureau of Standards

Introduction

To promote accuracy and uniformity in physical measurements, the National Bureau of Standards provides calibration and testing services for a wide variety of standards and instruments. These services, together with the fees for their perfomance, are listed in the following sections of this publication. However, calibration and testing are but one aspect of NBS service to science and industry; a brief résumé of some of the other services is presented below:

Standard Materials. NBS prepares and sells nearly 600 different standard materials whose chemical composition or physical properties have carefully been determined. These materials are used for standardizing solutions in volumetric analysis, for checking methods of analysis and evaluating their accuracy, and for calibrating spectrometers, calorimeters, *p*H meters, and other instruments. Among the standard materials offered by the Bureau are steels of certified composition, metals of known freezing temperature for use in thermometry, color standards, and radionuclides of known emission rate. A complete listing of the standard materials is available in NBS Misc. Publ. 241, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, for 30 cents.

Standard Radio Broadcast Services. The Bureau broadcasts standard time and frequency signals from radio stations WWV (Beltsville, Md.) and WWVH (Maui, Hawaii). These broadcasts, made on 2.5, 5, 10, 15, 20, and 25 Mc/s from WWV, and 5, 10, and 15 Mc/s from WWVH, provide standard radio and audio frequencies, time signals and standard time intervals, standard musical pitch, radio propagation forecasts, and alerts concerning outstanding geophysical events. To improve the accuracy of long-distance coverage, low-frequency stations WWVL (20 kc/s) and WWVB (60 kc/s) have been established in Colorado. Single copies of NBS Misc. Publ. 236, Standard frequencies and time signals from NBS stations WWV and WWVH, which describes these radio broadcasts, can be obtained by writing to the Office of Technical Information, NBS, Washington, D.C., 20234.

Note: If you wish to be placed on a mailing list to receive periodic listings of changes in fee schedules, please fill out and mail the post card inserted after p. 103.

The sections that follow are reprinted from the Federal Register of July 26, 1963, and amended November 7, 1963. As services are initiated or discontinued, or fees are changed, further announcements will appear in the Federal Register, and major changes will be noted in the Standards and Calibration column of the NBS Technical News Bulletin.

Code of Federal Regulations

Title 15—Commerce and Foreign Trade

(Reprinted from the "Federal Register" July 26, 1963—Vol. 28, No. 145, Part II, and November 7, 1963—Vol. 28, No. 218.)

Part 200—General[1]

200.1 Tests[2] performed by the National Bureau of Standards.

a. *Statutory functions:* The National Bureau of Standards has been assigned the following functions (15 U.S.C. 271–282):

(1) The custody, maintenance, and development of the national standards of measurement together with the provision of calibration services related to these standards.

(2) The determination of physical constants and properties of materials.

(3) The development of methods for testing materials, mechanisms, and structures and the testing of materials, supplies, and equipment.

(4) Cooperation in the establishment of standard practices, incorporated in codes and specifications.

(5) Advisory services to government agencies on scientific and technical problems.

(6) Invention and development of devices to serve special needs of the government.

The testing activities stem from the functions in subparagraphs (1), (3), and (4) of this paragraph. This schedule of fees lists the services that are available to the public.

b. *Testing policy:* (1) The Bureau's principal emphasis is on those calibrations and other tests requiring such accuracy as can be obtained only by direct comparison with NBS standards. The public is urged to obtain secondary standardization services from qualified sources other than the Bureau. Except in unusual circumstances, calibrations and other tests are performed for the users of the equipment rather than for suppliers. Tests that the Bureau undertakes are restricted to the following:

(i) Tests involving comparison of standards or instruments with NBS standards.

(ii) Tests of devices or materials to determine compliance with specifications or claims, only if the device or material is critical in national scientific or technical operations, and if suitable testing facilities are not available elsewhere.

(iii) Referee tests, to which paragraph (i) above does not apply, where private laboratories are unable to agree on the method of measurement, the results of tests, or the interpretation of these results, provided that the importance of the case justifies the test and that all parties agree in advance in writing to accept and abide by the findings of the Bureau.

(iv) Cooperative tests with national or international standardizing organizations to develop standards or specifications of mutual interest.

(2) Tests of the following types are not made for private organizations or individuals:

(i) Tests of devices and materials regularly performed by commercial laboratories. (A Directory of Testing Laboratories, Commercial and Institutional, is available from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103)

(ii) Tests of secret processes, or of inadequately described materials, devices, or processes.

(iii) Tests whose objective is public relations, advertising, or sales promotion.

(3) Requests for calibration of any equipment may be declined if, in the Bureau's opinion the equipment is not suitable for use as a plant or laboratory standard. The Bureau reserves the right to decline any request for testing, temporarily or permanently, if the tests would interfere with other activities deemed by the Director to be of greater importance.

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[1] Chapter II—National Bureau of Standards, Department of Commerce, Subchapter A—Test Fee Schedules.

Pursuant to authority contained in 15 U.S.C. 275a the following revision, effective upon publication in the Federal Register, supersedes in its entirety Subchapter A, Chapter II, Title 15 of the Code of Federal Regulations previously issued.

Authority: §§ 200.1 and 200.2 issued under sec. 9, 31 Stat. 1450, as amended; 15 U.S.C. 277. Interpret or apply sec. 7, 70 Stat. 959; 15 U.S.C. 275a.

[2] "Tests" as used herein includes calibrations.

c. *Request for tests:* (1) Except for specific tests listed in the fee schedule a preliminary letter, stating clearly the tests desired, should be sent to the National Bureau of Standards, Washington, D.C., 20234, or to the National Bureau of Standards, Boulder, Colo., 80310, as appropriate, prior to any shipment, to determine if and when and at which laboratory the Bureau can undertake the test. In general, the purpose of the test and the manner in which the results are to be used should be stated. A formal purchase order for the test should be sent prior to or at the time of shipment.

(2) A test number will be assigned by the Bureau to each item or group of items accepted, and this test number should be referred to in all subsequent communications. If the apparatus submitted has been previously calibrated by the Bureau, reference should be made in the letter or order to this test number.

(3) Acceptance of such orders does not imply acceptance of any provisions set forth in the purchase order contrary to the policy, practice, or regulations of the National Bureau of Standards or the U.S. Government. (A statement to the effect that the National Bureau of Standards is an agency of the U.S. Government should satisfy other Government agencies with regard to compliance with Government regulations and executive orders.)

d. *Packing, shipping, and insurance:* (1) Equipment sent to the Bureau must be properly packed by the applicant to minimize likelihood of damage in shipment and handling. Suggestions on packing and shipping are made in some sections of the fee schedule. In every case, the applicant should consider the nature of the equipment, pack it accordingly, and clearly label shipments containing fragile instruments or materials, glass, etc. The use of "security express" should be considered in shipping delicate instruments.

(2) Shipping charges both to and from the Bureau must be assumed by the applicant. It is generally impractical for the Bureau to prepay shipping charges and add this cost to the billing invoice. Return shipments are made by the Bureau in accordance with its judgment of the best method of shipping unless specific instructions are received. Such instructions should be clearly shown on the purchase order for the test. The Bureau cannot guarantee that instructions printed obscurely on the order will be followed. Parcel post shipments generally will be returned prepaid by the Bureau.

(3) When a test number has been assigned prior to shipment to the Bureau this number should be clearly marked on the shipping container. When a test number has not been assigned, an invoice, copy of the purchase order, or letter should be enclosed in the shipment to insure proper identification. The original purchase order should be forwarded to the Bureau.

(4) The risk of loss or damage, either in shipment or in testing, must be assumed by the applicant. Any arrangements for insurance covering such risk must be made by the applicant, except that the Bureau will, in other than parcel post shipments, request the carrier to provide insurance coverage for a specified amount for return shipment if this is specified by the applicant on the face of the purchase order. If transit insurance is carried by the applicant this should be stated on the face of the purchase order, and in any case the purchase order should show the value of the equipment.

e. *Identification:* The data reported in the Bureau's tests pertain only to the individual item or piece of apparatus tested. It is therefore essential that this piece be identified uniquely by an appropriate number or symbol. In most cases, the manufacturer's name and serial numbers are used When such a number is lacking, the applicant should provide an alternative identifying mark. If none is found, the Bureau may apply an appropriate one, usually the Bureau's test number, for which an additional charge may be made.

f. *Condition of apparatus:* All apparatus submitted for test must be in good operating condition. Repairs and adjustments should be attended to by the applicant prior to shipment. Apparatus not in good condition cannot be tested, nor can the Bureau undertake the repair or adjustment of any equipment, except by special arrangement. If it is evident that equipment has been abused or has not received proper care, a test ordinarily will not be conducted. If

defects are found at the Bureau after a test has begun, this fact will be reported, the test may be terminated and a report issued summarizing such information as has been found, and a fee charged in accordance with the amount of work done.

g. *Priority and time of test:* (1) In general, tests are undertaken in the order in which the requests are received, provided that the proper arrangements have been made and the information necessary for test performance has been received by the time the test is scheduled to start. When it is desired that apparatus be out of normal service for a minimum time, arrangements may in some cases be made in advance for the setting of a specific date for the test; in such cases shipment can then be made in accordance with this date.

(2) The time for the completion of tests depends on a number of factors. Some tests require considerable time in themselves, as is indicated in the fee schedules. The condition of submitted equipment, the test load in the Bureau's laboratories, and emergency work for the Government are other factors that enter into consideration. Time estimates made by the Bureau are therefore tentative.

h. *Witnessing of tests:* The Bureau welcomes scientists and engineers who may wish to visit its laboratories and discuss test methods. However, visitors ordinarily will not be permitted to witness the actual carrying out of highly precise measurements because their presence introduces distraction that may lead to errors or delays. This policy may be waived in those cases where the visitor can be of service in setting up apparatus of a new or unusual nature, in the case of referee tests, or in other cases in which the legal validity of the result may require the presence of duly authorized witnesses.

i. *Report of test:* Results of calibrations and other tests are issued as reports entitled "National Bureau of Standards Report of Calibration" or "National Bureau of Standards Report of Test," as appropriate. The report form used carries no special significance. Whenever formal certification is required by law, or to meet special conditions adjudged by the National Bureau of Standards to warrant it, a letter will be provided certifying that the particular item was received and calibrated or tested, and identifying the Report containing the results.

j. *Use of test results:* (1) The results of tests are pertinent only to the particular device or specimen tested and their application to other items of the same lot or type may not be warranted and therefore is not authorized by the National Bureau of Standards. However, the Bureau may declare that an entire lot of nominally identical items does or does not meet stated requirements for acceptance on the basis of tests on a sample of instruments or objects drawn from the lot in accordance with an approved sampling procedure.

(2) The National Bureau of Standards does not "approve," "recommend," or "endorse" any proprietary product or material as a class or group, and results reported by the Bureau shall not be used in advertising or sales promotion, or to indicate either explicitly or implicitly endorsement of the product or material by the National Bureau of Standards.

k. *Fees:* (1) In accordance with 15 U.S.C. 271–282, fees are charged for all tests made for the public.

(2) This fee schedule is published subject to the above-mentioned basic act which authorizes the Secretary of Commerce, from time to time, to make regulations regarding the payment of fees, the limits of tolerance to be obtained in standards submitted for verification, and related matters.

l. *Billing charges:* The minimum billing charge for any test request accepted by the Bureau is $5.00, unless otherwise indicated in a particular fee schedule. If apparatus is returned without testing a minimum charge of $5.00 may be made to cover handling. Fees for tests include the cost of preparation of an original report. Copies of reports ordinarily are not issued to other than the recipient of the original, and are not issued unless the applicant has shown a

technical need for them. Copies of reports requested subsequent to the date of tests will be supplied at a cost of $1.00 each. All checks should be made payable to NBS, Department of Commerce.

200.2 Location of Laboratories. The calibrations listed in Parts 201 (low-frequency), 202, 203, 204, 205, 206, 208, 210, and 215 of this subchapter are performed in the laboratories of the National Bureau of Standards at Washington, D.C., 20234. Many of the calibrations listed in Part 201 can also be performed at the NBS Boulder Laboratories, although in some cases only over limited ranges. Calibrations listed in Part 201 (high-frequency) are performed by the Radio Standards Laboratory of the National Bureau of Standards at Boulder, Colo., 80310. In general, electrical calibrations at frequencies higher than 30 kc/s are made at Boulder and those at lower frequencies are made either at Washington or at Boulder. Inquiries concerning calibrations (giving full details of ranges, frequencies, burdens, etc.) and shipment of apparatus should be directed in accordance with the foregoing. If apparatus is to be calibrated at both high and low frequencies, arrangements should be initiated with the Boulder Laboratories. The cost of shipping the apparatus between laboratories will be billed to the applicant.

Part 201—Electricity

The calibration service covered by this part includes the determinations of the corrections for standard electrical and electronic measuring apparatus and their range-extending auxiliaries used at power and audio frequencies (up to 30 kc/s), high frequencies (30 kc/s to 300 Mc/s), and microwave frequencies (above 300 Mc/s).

The Bureau does not test, except occasionally for other agencies of the Federal Government, electrical devices or supplies not directly related to the field of measurement. Tests of power transformers, motors, generators, relays, wiring, appliances, etc., should not be requested.

Resistance Measurements

Precision Wire-Wound Resistance Standards and Apparatus

Sec.

201.100 General
201.101 Precision standard resistors
201.102 Precision resistance apparatus

Resistance Standards Other Than Wire-Wound

201.103 Multi-megohm resistors

Inductance and Capacitance Measurements

201.104 Standard inductors
201.105 Standard capacitors; tests with alternating current

Electrochemistry

201.201 Standard cells

Electrical Instruments

201.300 General
201.301 Standard resistors for current measurements
201.302 Volt boxes (fixed-ratio voltage dividers)
201.303 A-c–d-c instruments and thermal converters
201.304 A-c–d-c wattmeters, single phase
201.305 Watthour meters

201.306 Current transformers
201.307 Current transformer comparators (testing sets)

Magnetic Measurements

201.400 General
201.401 General magnetic measurements; normal induction and hysteresis
201.402 Magnetic materials; alternating-current permeability and core loss
201.403 Magnetic testing apparatus; mutual inductors, search coils, and fluxmeters

Dielectric Measurements

201.500 Dielectric constant, dissipation factor

Voltage Ratio and High-Voltage Measurements

201.601 Voltage dividers
201.602 Voltage transformers
201.603 Voltage transformer comparators
201.604 Kilovoltmeters

High-Frequency Region

201.800 General
201.810 Rf, rf–d-c voltmeters, and thermal converters in the frequency range of 30 kc/s to 1000 Mc/s; from 0.2 to 300 v
201.811 Rf voltmeters and signal sources in the frequency range of 30 kc/s to 1000 Mc/s; from 1 μv to 0.1 v
201.820 Rf calorimeters, 30 kc/s to 400 Mc/s
201.830 Immittance, 30 kc/s to 1 Gc/s
201.840 Dissipative fixed coaxial attenuators
201.841 Dissipative variable coaxial attenuators
201.842 Waveguide below-cutoff (piston) attenuators
201.843 Coaxial fixed directional couplers
201.844 Coaxial variable directional couplers
201.850 Field strength measurements, 30 c/s to 1000 Mc/s

Microwave Region

201.900 General
201.910 Continuous, low-level power measurement of waveguide bolometer units and bolometer-coupler units
201.911 Continuous low-level power measurement of waveguide dry calorimeters
201.920 Reflection coefficient magnitude measurement on waveguide reflectors (mismatches)
201.930 Frequency measurement on cavity wavemeters
201.940 Attenuation difference measurements on variable attenuators
201.941 Insertion loss measurements on fixed attenuators
201.950 Effective noise temperature measurements on noise sources

Resistance Measurements

Involving Precision Wire-Wound Resistors

201.100 General. In general, 201.101 and 201.102 apply only to apparatus embodying the following essential features:

(a) The resistance material should have a low temperature coefficient, should not change its resistance appreciably with time, and for low-valued coils should have a small thermoelectric power against copper.

(b) All wire standard resistors and the more important section of resistance apparatus for use in d-c circuits should be wound on metal or ceramic supports, preferably in a single layer. Electrical connections to the resistance material should be brazed in all cases in which the total resistance is less than 1,000 ohms. The resistance material should be protected against oxidation and other chemical action and should be annealed or aged by baking after winding.

(c) Precision standard resistors should be so adjusted as to give an accuracy of at least

0.02 percent without corrections. Precision resistance apparatus should be adjusted within 0.05 percent of nominal value.

(d) Because comparatively rapid changes in resistance take place in new apparatus, it is not advisable to calibrate new or repaired apparatus until at least two months after the resistors have been annealed and adjusted. Precision apparatus known to be new will be held in the laboratory (in the absence of other instructions) for at least a month, when the measurements will be repeated to determine the drift in value, if any. No extra charge is made for these later measurements. Occasionally during the course of calibration it is discovered that the standard or instrument under observation is defective and in need of repair. In such instances the item in question will be rejected and a fee equal to the published fee, in whole or in part, will be assessed commensurate with the effort expended before the calibration was halted.

(e) Unless otherwise stated, the tests listed are generally made using a direct current of such magnitude as to cause only a negligible heating of the resistance material. Calibrations of standard resistors, bridges, and decade resistors consist of determinations of the resistance of the standards or of the resistance of the elements of the bridges or similar apparatus from which values corresponding to all possible readings can be computed. Measurements of potentiometers consist of determinations from which the ratios of the resistances corresponding to all possible readings can be computed. Precision standard resistors are ordinarily measured at a temperature of 25 °C, while resistance apparatus is measured at room temperatures, usually from 22 to 25 °C.

(f) The Bureau does not calibrate portable self-contained test equipment having relatively low accuracy such as portable potentiometers, resistance test sets, and double-bridge ohmmeters. The accuracy of these devices is such that a complete detailed determination of corrections is not economically feasible. Apparatus of this type may be spot-checked by measuring known voltages or resistances with them. Adequate calibration services of this type can be obtained from a number of commercial testing laboratories.

201.101 Precision standard resistors. Standards of 10 ohms and less of the precision type provided with amalgamated current terminals and designed for oil immersion must be of the four-terminal type, that is, must have both current and potential terminals. The resistance of standards having nominal values in the range 0.0001 ohm to 100,000 ohms will usually be given to the nearest 0.0001 percent in terms of the calibrating unit (the legal unit) maintained by the Bureau with a group of 1-ohm standard resistors. Each report of calibration will state the accuracy of the reported value at the time of calibration. This accuracy will vary from 0.0001 percent for Thomas-type 1-ohm standards to 0.002 percent for resistors of nominal value 0.001 ohm. Additional information regarding standard resistors may be found on the back of the report of calibration.

Item	Description	Fee
201.101a	Determination of resistance in oil bath at 25 °C. For all standards having resistances in the range 0.0001 to 100,000 ohms, inclusive, provided they are adjusted within 0.05 percent of a nominal value which is itself a decimal multiple (or submultiple) of 1 ohm	$32.00
201.101b	Determination of resistance in oil bath at 25 °C. For odd-valued standards not falling within the scope of item 201.101a	47.00
201.101c	Measurement of resistance in oil bath at 20, 25, and 30 °C, and determination of temperature coefficient. Such measurements are made only when it is shown that the small changes in resistance resulting from necessary variations of the temperature from 25 °C are of importance	115.00

Item	Description	Fee
201.101z	For special calibrations not covered by the above schedule, advance arrangement must be made. Fees will be charged dependent on the time involved in making a calibration.	

201.102 Precision resistance apparatus. Corrections pertinent to apparatus of suitable quality submitted under this section will ordinarily be reported to a number of significant figures so chosen that normal variation of ambient conditions within the stated bounds of test conditions will not affect the corrections by more than a few units in the last place reported. Calibrations will be made at room temperature, usually 22 to 25 °C.

Item	Description	Fee
201.102a	Precision decade and plug boxes. For decades not exceeding 10,000 ohms per step.	
	(1) First point in each box	$15.00
	(2) Each additional point in same resistance box	5.00
201.102b	Megohm box, 10 sections each 100,000 ohms	145.00
201.102c	Wire-wound 0.1- to 100-megohm boxes with 10 equal sections—calibration with all sections in parallel	47.00
201.102d–1	Precision Wheatstone bridges	385.00
201.102d–2	Calorimetric bridges of all kinds	520.00
201.102e	Potentiometers, minimum steps 10 μv or more	220.00
201.102f	Potentiometers, minimum steps less than 10 μv	410.00
201.102g	Kelvin bridge ratio box	160.00
201.102h	Double ratio set for Kelvin bridge, with double set of fixed and variable arms	465.00
201.102i–1	Four-dial precision resistive voltage divider	260.00
201.102i–2	Five-dial precision resistive voltage divider	320.00
201.102i–3	Six-dial precision resistive voltage divider or universal ratio set	350.00
201.102z	For special tests not covered by the above schedule, advance arrangements must be made. Fees will be charged dependent on the time involved in making the tests.	

Resistance Standards Other Than Wire-Wound

201.103 Multi-megohm resistance standards—except wire-wound. Measurements made on resistors submitted under this section are accurate to 0.1 percent at the time of test if nominal values are in the range 10^6 to 10^{12} ohms; for higher-valued resistors the accuracy is 0.5 percent. In order that the reported results be of significance it is necessary that standards submitted for tests be made of suitable materials processed in such a manner that resistance values do not change rapidly with time. They should be so constructed and treated that the effect of relative humidity is minimized. The resistance of these standards usually depends on the magnitude of the applied voltage; the test voltage should therefore be specified. Each resistor should have an identifying number engraved on or permanently attached to it.

Item	Description	Fee
201.103a	Determination of resistance of a resistor at one voltage (1.5 to 250 v) at room temperature (23 °C) and humidity (50% rh or less) when the resistor has a nominal value between 10^6 and 10^{10} ohms	$25.00
201.103b	Determination of resistance of a resistor at one voltage (1.5 to 250 v) at standard laboratory temperature (23 °C) and humidity (50% rh or less) when the resistance is higher than 10^{10} ohms but the current involved is not less than 10^{-12} amp	40.00
201.103c	Determination of resistance of a resistor at each voltage (1.5 to 250 v) at standard laboratory temperature (23 °C) and humidity (50% rh or less) when the current involved is less than 10^{-12} amp but not less than 10^{-13} amp	50.00
201.103z	For special tests not covered by the above schedule, advance arrangements must be made. Fees will be charged dependent on the time involved in making the tests.	

Inductance and Capacitance Measurements

NOTE: Tests at radiofrequencies are performed at the NBS Boulder Laboratories, Boulder, Colo., 80310.

201.104 Standard inductors.

(a) Inductors for use in a-c bridges are ordinarily tested at 100, 400, 1,000, or 10,000 c/s at a room temperature of 23 °C and a relative humidity of 50 percent or less. Measurements at 10,000 c/s are limited to standard inductors of 0.1 henry or less. Most inductors used at 60 c/s can be tested at 100 c/s since the variation of inductance with frequency in this range is usually negligible. Purchase orders should state which frequency or frequencies are to be used for calibration purposes. A metal-encased standard is calibrated with the case connected to the "low" terminal of the inductor unless other conditions are specified. Variable inductors used as circuit elements in laboratory setups are low-accuracy devices which do not come within the purview of this schedule and should not be submitted for calibration. Q values are not supplied for inductors calibrated under this schedule. Inductors intended for use as Q standards at radiofrequencies should be referred to the Boulder Laboratories. Mutual inductors used in mag-

netic testing for calibrating ballistic galvanometers should be calibrated with direct current under item 201.403a.

(b) Accuracy: Inductance values and accuracy statements given in reports of calibration depend upon two factors: (1) the accuracy of the comparison of the client's inductor with the NBS working standards of inductance; (2) the uncertainty in the derivation of the unit of inductance which is embodied in the NBS working standards. In general, inductance values will be given to as many significant figures as are justified at the time of measurement. The accuracy figure given in each report of calibration takes into account factors (1) and (2) stated above and will vary from 0.02 percent to 0.2 percent depending upon the nominal value of the inductor and the frequency of the test current employed.

(c) Inductors can usually be shipped safely express but should be carefully packed to avoid damage to the coil fastenings and terminals.

Item	Description	Fee
201.104a	Determination of self or mutual inductance of a fixed inductor with non-magnetic core at one frequency, 100, 400, 1,000, or 10,000 c/s	$30.00
201.104b	Determination at an additional frequency 100, 400, 1,000, or 10,000 c/s on an inductor tested under 201.104a	20.00
201.104z	For special calibrations not covered by the above schedule, advance arrangements must be made. Fees will be charged depending upon the nature of the calibration.	

201.105 Standard capacitors.

(a) Calibrations are ordinarily performed at 65, 100, 400, 1,000, and 10,000 c/s with an ambient temperature of about 23 °C and a relative humidity of 50 percent or less.

(b) The accuracy stated in the report of calibration is determined in part by the accuracy of the NBS measurements and in part by the performance characteristics of the capacitor itself and is sufficiently broad to allow for variations in the stray capacitance at the connectors, variations in temperature of a few degrees Celsius, considerable variation in relative humidity and atmospheric pressure, and frequency deviations of a few percent from the stated test conditions. Over the above frequency range, and in the capacitance range from 0.001 pf to 100 μf, the available accuracy usually lies in the range 0.002 to 0.5 percent.

(c) The capacitance value given is the equivalent parallel capacitance. In general a determination of the equivalent parallel conductance with high accuracy is not feasible; however, for solid dielectric capacitors an approximate value is given without additional charge.

(d) Continuously adjustable ("variable") capacitors are no longer calibrated by the Bureau.

(e) In applying the following schedule to decade capacitance boxes the first entry (201.-105a) applies to a determination of the zero capacitance and conductance of the box (all dials set at zero). The second entry applies to the determination of the capacitance and conductance added to the circuit when any one dial is advanced from zero to a specified setting, and at the frequency used in determining zero capacitance. For measurements at additional frequencies the schedule is applied in the same manner, i.e., the higher fee is used for the first point (zero calibration) at the new frequency, and the lower fee applies to additional points at that frequency.

Item	Description	Fee
201.105a	Determination of either direct or grounded capacitance of a fixed capacitor or one section of a subdivided capacitor, with alternating current at one frequency selected from those listed above (201.105)	$35.00
201.105b	Determination of either direct or grounded capacitance of each additional point on the same subdivided capacitor submitted under item 201.105a	12.00
201.105z	For special calibrations not covered by the above schedule, advance arrangements must be made. Fees will be charged dependent on the time involved in making the calibration.	

Electrochemistry

201.201 Standard cells.

(a) Unsaturated standard cells will be accepted for calibration by the Bureau only from public utilities and others having operations of such a nature as to require calibrations by the Bureau.

(b) Unsaturated cells normally require about two weeks for a complete calibration. The cells are kept in a thermally insulated cabinet and readings of their emf are taken daily for a period of ten days after the values have become reasonably constant. If the emf continues to fluctuate, or is unusually low, or if the cell shows other abnormal indications, the nature of the failure is stated. Unsaturated cells are not likely to be injured by normal transportation (mail or express), if they are carefully packed. Shipment during very cold weather should be avoided because of the possible hazard from freezing.

(c) Saturated cells should be transported by messenger because they should never be inverted nor tipped more than 45°. In order that the reported values are of the highest accuracy the emfs of saturated cells are measured while they are kept 6 to 8 weeks in an NBS temperature-controlled oil bath or in their own thermoregulated air bath.

Item	Description	Fee
201.201a	Cadmium standard cell (unsaturated type), determination of electromotive force with accuracy of 0.01 percent	$29.00
201.201b	Cadmium standard cell (saturated type), measurement of the first cell of a group at a fixed temperature of 28 °C, in thermostatically controlled oil bath or at a fixed temperature in a thermoregulated air bath	58.00
201.201c	Each additional saturated cell of a group	29.00
201.201d	Cadmium standard cell (saturated type), measurement of the first cell of a group at any temperature between 20 and 35 °C, except 28 °C, in a thermostatically controlled oil bath	71.00

Item	Description	Fee
201.201e	Each additional cell of a group (at temperatures between 20 and 35 °C, except 28 °C, in a thermostatically controlled oil bath)----------	$34. 00
201.201z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

Electrical Instruments

201.300 General.

(a) Indicating (pointer-and-scale) instruments should be calibrated quite frequently with d-c standards and a-c–d-c transfer instruments, or with stable d-c or a-c sources which are calibrated periodically in this way. Suitable standards and transfer instruments are now readily available commercially. Because of the necessity of frequent tests, a single d-c or a-c calibration of an indicating instrument has little permanent value. Thus in this category the Bureau ordinarily accepts for calibration only rms a-c–d-c instruments and thermal converters of 0.1 percent rated accuracy or better, for a-c–d-c difference tests only.

(b) The Bureau's a-c–d-c difference tests consist of determination of the difference between quantities (current, voltage, or power) required to give the same response (output) of an instrument or thermal converter on alternating current and on reversed direct current, as evaluated by comparison with an NBS a-c–d-c transfer standard. The alternating quantity, Q_a, required for a given response of the instrument or converter is then $Q_a = Q_d\ (1+S)$ where Q_d is the average quantity required for this response on reversed direct current, as determined by d-c standards, and S is the small fractional a-c–d-c difference. Usually NBS a-c–d-c difference tests are made on each range of the instrument or converter. The differences depend on the ratios of the reactances of the components, and increase with frequency, but are small and relatively permanent over the rated frequency range of a well-designed instrument. Therefore, NBS tests are normally made only at the upper rated frequency on each range and at the lower rated frequency on one range. Ordinarily, the tests need not be repeated at intervals of less than five years, and then only if the instrument is to be used over the upper part of its frequency range.

201.301 Standard resistors for current measurements.

(a) Calibration: The Bureau normally calibrates only resistors of 0.04 percent accuracy or better. Test results for suitable standard resistors for current measurements are usually reported to an accuracy of 0.01 percent.

(b) Design: A standard resistor for current measurements is a four-terminal resistor, for which the resistance is defined as the ratio of the open-circuit potential difference between the potential terminals to the current through the current terminals. The resistance value will be definite and reproducible only if the current flow pattern at the potential terminals is completely reproduced. This flow pattern should be fixed by resistor design to be independent of the way in which current is introduced at the current terminals and of the location of leads on the potential terminals. In some instances where this has not been done the type and location of connections to the current terminals can be specified adequately to fix the flow pattern at the potential terminals.

(c) High-current resistors: Resistors for high currents (above about 1,000 amp) require considerable power, so that their temperature rise between low and rated current, and the resulting change in resistance, will depend not only on their design, including means provided for dissipating heat, but also on the connecting bus bars and their junctions to the resistor. Bus bars of generous cross section may carry away a significant part of the heat generated in the resistor; inadequate bus bars may actually contribute to the heating of the resistor. In addition, contact resistance at the points of connection to the bus bars, unless carefully minimized, may contribute appreciably to the heating. (Contact resistance of bolted connections

depends on area of contact, cleanness of surfaces, and pressure.) Resistance determinations made in the laboratory at rated current may therefore be of little value because the working temperature conditions cannot be duplicated. The best experimental procedure to use in such cases is to place the standard in a temperature-controlled enclosure and measure its resistance with a comparatively low test current when it is heated uniformly to temperatures approximating that at which it will operate in service (201.301d and e). From data at two or more elevated temperatures, combined with that at room temperature, a curve can be plotted from which the resistance at the operating temperature can be read, provided this temperature is determined by the user with the resistor under the actual operating conditions.

Changes in resistance may also result from strains in the resistance element produced by mechanical forces incidental to clamping the resistor connections, as well as from inherent internal expansion constraints on resistor parts, or forces from the magnetic field produced by the current.

(d) Test schedule: Resistors when first submitted for test should be tested with about 20 percent of rated current and with full rated current; normally when resubmitted for test, determinations need be made only with 20 percent of rated current; once stability is proved, the resistor need not be recalibrated at intervals of less than two years.

Item	Description	Fee
201.301a–1	Initial determination of resistance of a single-range resistor or one range of a multirange resistor, at 30 percent rated current or less (current rating not to exceed 300 amp)	$44.00
201.301a–2	Same as a–1, except current rating above 300 amp but not to exceed 1,000 amp	74.00
201.301b	Determination of resistance on another range of a multirange resistor, at 30 percent rated current or less (current rating not to exceed 300 amp)	16.00
201.301c	Test according to item 201.301a or 201.301b having been made, for an additional determination at another test current (not to exceed 1,000 amp)	22.00
201.301d	Additional determination of resistance at temperatures above room temperature at a current not greater than 30 percent rated, for first elevated temperature	74.00
201.301e	Additional determination of resistance of each additional elevated temperature, at a current not greater than 30 percent rated	18.00
201.301f	Twenty determinations of resistances corresponding to 9 plug positions and 11 slider positions of an adjustable low-resistance standard, at 30 amp	220.00
201.301z	For determinations of resistance at currents larger than 1,000 amp and requiring unusual setups or procedures, and for special tests not covered by the above schedule, advance arrangements must be made. Fees for such tests will depend upon the nature of the test.	

201.302 Volt boxes (fixed ratio voltage dividers). A volt box is a resistive voltage divider used to extend the range of the voltage measured by a potentiometer. Its ratio for

any range is obtained by dividing the voltage across its input terminals by the open-circuit voltage across the section to be connected to the potentiometer.

(a) Calibration: The Bureau normally calibrates only volt boxes for which the maker's stated ratio accuracy is 0.04 percent or better. Values of ratio are normally reported to an accuracy of 0.005 percent.

(b) Humidity effects: The insulating structure of a volt box is equivalent to a network of high resistances in parallel with one or more of its wire-wound precision resistance elements. Thus, changes in insulation resistance as a result of variations in surface or volume moisture may affect the ratios. Such ratio changes are normally less on low than on high ratios. This effect can be reduced or eliminated by constructions which provide built-in guard electrodes, maintained at appropriate potentials. Another effect of humidity is to produce changes in the values of the precision wire-wound resistors. The magnitude of this effect varies with coil construction and with wire size and coating. Because humidity effects may reach equilibrium only after days (or even weeks), it is recommended that laboratory humidity be held continuously at or below 50 percent.

(c) Ambient temperature and self-heating effects: Changes in ambient temperature should have little effect on ratio if all the resistance elements have the same temperature coefficient. However, self-heating as a result of sustained operation may significantly change the ratios because of unequal temperature rise in the various resistors. The magnitude of this effect depends on construction and coil arrangement, and on the power dissipated. It should (1) be less for low than for high ranges, (2) be greater for volt boxes that require higher current at rated voltage, (3) increase approximately with the square of the applied voltage, and (4) be entirely negligible at 20 percent of rated voltage on all ranges.

(d) Suggested test schedule: Volt boxes should be tested at rated voltage. The first calibration test should also include a test at 20 percent rated voltage on one or more of the higher ranges, which are preferably selected by the Bureau. The equilibrium values at 20 and 100 percent rated voltage may be used to estimate the magnitude of the self-heating effects for the various ranges. Tests having once been made at 20 and 100 percent rated voltage, subsequent determinations need be made only at rated voltage, since the self-heating effect should not change with time.

Once stability has been established, a volt box should not require recalibration at intervals less than two years.

Item	Description	Fee
201.302a–1	Determination of ratio on one range at rated voltage, not to exceed 1,500 v, and at a ratio not to exceed 5,000/1	$67.00
201.302a–2	Determination as in (1) above except ratio not to exceed 10,000/1	100.00
201.302b	Determination of ratio at rated voltage on an additional range	16.00
201.302c	Determination at a reduced voltage on a range tested in 201.302a or b	9.00
201.302d	Test per range, at rated voltage, of a multirange guarded standard voltage divider. (Design similar to that described in NBS RP1419.) Value normally reported to an accuracy of 0.001 percent	20.00
201.302z	For tests on volt boxes not covered by the above schedule advance arrangements must be made. Fees will be charged depending upon the nature of the test.	

201.303 A-c–d-c instruments and thermal converters (20 to 50,000 c/s, up to 50 amp and 600 v). Ordinarily only rms a-c–d-c instruments or converters of 0.1 percent rated accuracy or better are accepted for test, which consists of a-c–d-c difference determinations by the procedures of items 201.303a to c. See 201.300.

Item	Description	Fee
201.303a	Initial determination of a-c–d-c difference of an instrument or converter at one applied voltage or current, frequency from 20 through 50,000 c/s	$33.00
201.303b	Each additional determination of a-c–d-c difference of the same instrument, converter, or set of converters, frequency from 20 through 20,000 c/s	10.00
201.303c	Each additional determination of a-c–d-c difference of the same instrument, converter, or set of converters, frequency from 20,000 through 50,000 c/s	20.00
201.303z	For special tests not covered by the above schedule advance arrangements must be made. Fees will be charged depending upon the nature of the test. For tests at higher voltages see 201.604	

201.304 A-c–d-c wattmeters, single phase (20 to 2,000 c/s, up to 15 amp and 500 v). Ordinarily only single-phase a-c–d-c wattmeters of 0.1 percent rated accuracy or better are accepted for test, which consists of a-c–d-c difference determinations by the procedures of items 201.304a to c. See 201.300. Unless otherwise specified, these tests are made at two scale points at 0.5 power factor on a base range and one scale point at other combinations of ranges, followed by tests at unity power factor at one scale point on one or more ranges, depending upon the results obtained.

Item	Description	Fee
201.304a	Determination of the difference between the reading on reversed direct current and the reading on alternating current at the first scale point at which this difference is determined, at currents not to exceed 15 amp	$44.00
201.304b	Determination of this difference at one scale point on an additional range, frequency, or power factor, at currents not to exceed 15 amp	16.00
201.304c	Determination at each additional scale point with the same combination of range, frequency, and power factor, at currents not to exceed 15 amp	7.00
201.304z	For frequencies greater than 70 c/s and for special tests not covered by the above schedule, advance arrangements must be made. Fees will be charged depending upon the nature of the test.	

201.305 Watthour meters. Except under unusual circumstances, only portable standard watthour meters (rotating standards) will be accepted for test. Tests consist of

determinations of the percentage registration of the meter "as received." If meters are to be cleaned and adjusted this must be done before they are submitted for test. The Bureau does not undertake the cleaning and adjustment of meters and does not knowingly begin tests on faulty meters. Before tests can be started the test conditions must be completely specified by the user as to current and voltage ranges to be tested, frequency, applied voltage and current, and power factor. A guide listing a limited yet adequate schedule of tests is available at no charge. Test voltages should be chosen from the following values: 1, 2, or 4 times 110, 115, 120, 125, and 130 v. Test current should be chosen from the following values: 1, 10, or 100 times 0.25, 0.5, 0.75, 1, 1.25, 1.5, 2, 2.5, 3, 3.75, 4, 5, 7.5 amp (but not to exceed 100 amp). Tests at other voltages or currents, or at power factors other than 1.0 and 0.5 current lagging, will be considered as special tests, because rearrangements of circuits are required (see 201.305z). Unless otherwise specified, test runs on portable standard watthour meters (rotating standards) are of approximately 100 sec duration. The meters are energized for at least 30 min at rated voltage and current on one range before starting the test.

Item	Description	Fee
201.305a	Test at 60 c/s on one combination of range, applied voltage, and power factor, at not more than five current loads	$54.00
201.305b	Additional test on the same or an additional combination of range, applied current, voltage, and power factor	8.00
201.305c	Test of one or two additional meters simultaneously with first, under the same conditions as 201.305a, per meter	28.00
201.305d	Test of each additional meter simultaneously with the first, under the same conditions as 201.305b, per meter	4.00
201.305z	For special tests not covered by the above schedule advance arrangements must be made. Fees will be charged depending upon the time required for the test.	

201.306 Current transformers.

(a) Calibration: The Bureau normally calibrates only current transformers of high quality for use as reference standards. The Bureau may decline requests for tests which are not to be used for establishing or checking a reference standard. If the transformer quality is stated in terms of ASA accuracy classes, calibration will normally be limited to transformers stated to be in the 0.3 percent class for one or more ASA burdens. Bureau equipment is primarily designed for testing current transformers whose rated secondary current is 5 amp. Results obtained at frequencies near 60 c/s will normally be reported to an accuracy of 0.05 percent in ratio and 1 min in phase angle. However, in some instances the ratio can be reported to an accuracy of 0.02 percent and the phase angle to 0.5 min.

(b) Test information: Tests cannot be started until information is furnished concerning the following conditions: (1) test frequency, (2) secondary test currents, (3) secondary burdens, (4) ranges to be tested. It is customary to make tests at secondary currents of 0.5, 1, 2, 3, 4, and 5 amp.

(c) Transformer burden: Current transformers should be tested with burdens equivalent to the impedances imposed when the transformer is used as a reference standard. Inclusion of tests at ASA burdens is not recommended. The burdens listed in the American Standard for Instrument Transformers, C–57.13, are for rating purposes only and differ from the instrument burdens imposed on a reference standard. Large errors in measurement can

result if the values of ratio and phase angle obtained with an ASA burden are used for the transformer when it supplies only an instrument burden.

Preferably the burden should be specified in terms of the measured resistance and inductance, including the leads to connect the instruments to the secondary of the transformer. If this measurement cannot be made conveniently, it will suffice in most cases to state the name of the maker, the type, range, and serial number of each instrument used in the burden, and the length and size of the wire of the leads used in the secondary circuit. Alternatively the burden may be stated in terms of the volt-amperes and power factor of the secondary circuit at the test frequency.

The test equipment regularly used at the Bureau imposes a minimum test burden of about 0.16 ohm with a minimum inductance of about 10μh (if the burden inductance is larger than 10μh, the minimum resistance is increased above 0.16 ohm). Special test equipment and procedures must be used for burdens lower than 0.16 ohm, so that advance arrangements must be made and higher fees must be charged. In planning for the tests of a transformer it is therefore desirable to select a low burden, but one larger than this minimum, preferably not less than 0.2 ohm. The required total may be made up by incorporating resistance in the leads to the instruments.

(d) Multirange current transformers, in which the same sections of primary windings are used in series and in parallel, usually have phase angles and ratio factors which are equal on the several ranges to within the accuracy needed for almost any measurement purpose. Hence a test at six values of secondary current on one range is nearly always sufficient to determine the characteristics of the transformer. Further tests, often made at 0.5 and 5 secondary amperes on each additional range, merely serve as a safeguard by means of which mistakes in winding may be detected. When the various ranges of a multirange transformer are obtained by taps on either winding, this relation does not necessarily hold, particularly in the case of secondary taps; and tests in addition to the initial six-point test on one range should be made, using two values of secondary current on each of the ranges so obtained. Transformers of some designs, however, show very little difference in ratio factor and phase angle on the various ranges, and the Bureau should be consulted before tests on a large number of ranges are requested.

(e) Demagnetization: Unless otherwise specified, current transformers will be demagnetized before being tested. If it is desired to have a transformer tested as submitted (without demagnetization), this fact should specifically be stated.

(f) Test limitation at frequencies greater than 60 c/s: At 400 c/s, the maximum current range for which tests are made is about 200 amp and the phase angle values are normally reported to an accuracy of 3 min; at 800 c/s there is a further reduction in the current range and accuracy. If the burdens at these higher frequencies are specified in terms of volt-amperes and power factor, the frequency for which these values are stated must be clearly indicated so that the proper burden resistance and inductance can be duplicated.

(g) Recalibration: At room temperature the ratio and phase angle under a specified test condition should be repeatable unless the core is magnetized. Once stability has been demonstrated a current transformer should not require recalibration at intervals less than 5 years.

Item	Description	Fee
201.306a–1	Determinations of the ratio and phase angle of a current transformer on one range at one frequency and one burden (not less than 0.2 ohm resistance) at not more than six values of secondary current, namely, 0.5, 1, 2, 3, 4, and 5 amp unless otherwise specified; primary current not to exceed 500 amp	$87.00

Item	Description	Fee
201.306a–2	Same as a–1 except primary current greater than 500 amp but not to exceed 8,000 amp	$115.00
201.306b–1	Determinations of the ratio and phase angle at one value of secondary current on an additional combination of frequency, range, and burden (not less than 0.2 ohm resistance); primary current not to exceed 500 amp	18.00
201.306b–2	Same as b–1 except primary current greater than 500 amp but not to exceed 8,000 amp	26.00
201.306c	Determinations of ratio and phase angle at an additional value of secondary current with the same combination of frequency, range, and burden used in 201.306 a or b, primary current not to exceed 8,000 amp	9.00
201.306z	For tests of current transformers at frequencies other than 25, 50, or 60 c/s, or with burdens less than 0.2 ohm resistance, or with primary currents greater than 8,000 amp, and for special tests not covered by the above schedule advance arrangements must be made. Fees will be charged depending upon the nature of the test	----

201.307 Current transformer comparators (testing sets).

Item	Description	Fee
201.307a	Determination of the values of current ratio and phase angle for settings of the dials of a current transformer comparator for 60 c/s (not exceeding 13 points on ratio dial and 15 on phase angle dial)	$265.00
201.307b	Determination according to 201.307a having been made, for 10 determinations at 25 c/s or for determinations on the second range of a double-range comparator	40.00
201.307z	For special tests not covered by the above schedule, advance arrangements must be made. Fees will be charged depending upon the nature of the test	----

Magnetic Measurements

201.400 General.

(a) A general discussion of magnetic principles and methods used in magnetic testing is given in NBS Monograph 47, Basic magnetic quantities and the measurement of the magnetic properties of materials. Price 30 cents. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. See p. 103 for order blank.

(b) Tests in this field are for the most part made on samples which serve as standards to coordinate work in various laboratories and thus secure uniformity in commercial testing. For this purpose it is essential that the standard bars be very uniform in their magnetic properties. The Bureau does not normally make routine acceptance tests of magnetic materials unless these specimens are to be used, at least temporarily, as standards. The standard dimensions of magnetic test specimens are given in 201.401 and 201.402. It is occasionally

possible to test specimens of unusual materials or shapes where the services of the Bureau are needed in the development of new test procedures which are likely to be of importance in the industry. In such cases a full understanding of the problem should be developed by correspondence, or preferably by a visit which will permit direct discussion between the engineers concerned and the Bureau staff.

201.401 General magnetic measurements; normal induction and hysteresis. Specimens submitted for test should be of rectangular cross section, width not to exceed 3.0 cm (1⅛ in.); thickness not to exceed 1.0 cm (⅜ in.); for magnetizing forces from 0 to 300 or 0 to 5,000 oersteds, length to be not less than 25.4 cm (10 in.); for magnetizing forces in the range 100 to 5,000 oersteds, length to be not less than 7 cm (2⅝ in.). Specimens whose permeability is not greater than 4 may be of circular cross section, diameter not to exceed 1.27 cm (½ in.) but in any event cross-sectional area must be not less than 0.2 cm^2 (0.031 $in.^2$).

Item	Description	Fee
201.401a	Determination of data for normal induction curve in the range 0 to 300 oersteds	$50.00
201.401b	Determination of data for normal induction curve in the range 100 to 5,000 oersteds	50.00
201.401c	Determination of data for normal induction curve in the range 0 to 5,000 oersteds	90.00
201.401d	Determination of data for demagnetization curve, one value of magnetizing force	60.00
201.401e	Same as 201.401d, each additional value of maximum magnetizing force	40.00
201.401f	Determination of permeability for specimens whose permeability is less than 4; first specimen	20.00
201.401g	Each additional specimen submitted at the same time	10.00
201.401z	For examination of material found to be unsuitable for test, or for special tests not covered by the above schedule, fees will be charged dependent on the cost of such examination or special test.	

201.402 Magnetic materials; a-c permeability and core loss. Test specimens should consist of the proper number of strips 3 cm (1³⁄₁₆ in.) wide and either 28 cm (11⅛₂ in.) to 30.5 cm (12 in.), or 50 cm (19 11⁄16 in.) long prepared in accordance with the specifications of the American Society for Testing and Materials, A–34.

Item	Description	Fee
201.402a	Determination of total core loss at 60 c/s at one value of maximum induction	$45.00
201.402b	Same as 201.402a, each additional value of maximum induction	15.00

Item	Description	Fee
201.402c	Determination of a-c permeability at 60 c/s at one value of maximum induction	$45.00
201.402d	Same as 201.402c, each additional value of maximum induction	15.00
201.402z	For examination of material found to be unsuitable for test, or for special tests not covered by the above schedule, fees will be charged dependent on the cost of such examination or special test.	

201.403 Magnetic testing apparatus; mutual inductors, search coils, and fluxmeters.

Item	Description	Fee
201.403a	Determination of mutual induction by direct current	$30.00
201.403b	Same as 201.403a, each additional inductor submitted at the same time or each additional value for variable or tapped inductors	15.00
201.403c	Determination of the area-turns of a search coil, first coil	35.00
201.403d	Each additional search coil submitted at the same time	20.00
201.403e	Calibration of fluxmeter at not more than five points on one range	45.00
201.403f	Calibration of fluxmeter at one scale point on an additional range	10.00
201.403g	Calibration of standard magnets	30.00–70.00
201.403z	For examination of apparatus unsuitable for test, or for special tests not covered by the above schedule, fees will be charged dependent on the cost of such examination or special test.	

Dielectric Measurements

201.500 Dielectric constant and dissipation factor. In general, the Bureau will make tests of insulating and dielectric properties of materials only on (1) specimens of known composition of pure materials for which values are considered of use by the Bureau, or by other government agencies; and (2) dielectric reference standards made from materials exhibiting reproducible behavior under specified environmental conditions (such as humidity), when such standards are needed for improving methods of measurement. Measurements are not made on the effective insulation resistances, dielectric constant or dissipation factor of structures and assemblies of insulation, or on electric breakdown generally. Inquiries giving comprehensive information regarding any tests desired from low frequencies up to 30 kc/s should be directed to the National Bureau of Standards, Washington, D.C., 20234. Inquiries concerning tests above 30 kc/s should be addressed to the National Bureau of Standards, Boulder, Colo., 80310.

Voltage Ratio and High-Voltage Measurements

NOTE: See section 201.102 for information relative to the calibration of resistive voltage dividers with direct current. See section 201.302 for information relative to the calibration of volt boxes.

201.601 Voltage dividers.

(a) The calibration of ratio devices such as voltage dividers need not be referred to the national standards of inductance or resistance or to any other national standard. However, methods and equipment are available at the Bureau for the measurement of alternating-voltage ratios with high accuracy, and a routine calibration service for first-quality decade inductive voltage dividers is provided. Inductive voltage dividers which incorporate a resistive divider as a fine adjustment are not accepted for calibration.

(b) The largest contribution to instability in inductive voltage dividers often arises in the decade switches. Variable contact resistance in these switches sometimes affects the stability of voltage-ratio measurements to a significant extent but is most evident by its effect on the phase angle. When a decade inductive divider exhibits large changes in phase angle on repeated measurements after the switches have been disturbed, the divider should no longer be considered satisfactory for use as a standard of voltage ratio.

(c) Corrections for the separate decades of an inductive divider, in general, cannot be simply combined; however, the correction to a step setting of one of the higher decades is usually independent of the setting of the lowest decades. Stray impedances must be fixed by connecting the case to the divider at one point; and unless otherwise specified, the case will be connected to one of the common terminals. Calibration intervals of three years should be satisfactory for good quality inductive voltage dividers which have not been abused.

(d) Decade inductive voltage dividers are calibrated at the Bureau by a comparison method, using as a working standard a well-constructed inductive divider which has previously been calibrated by capacitance-ratio methods. The comparison method is simple and convenient and can be used in other laboratories for the rapid calibration of other voltage dividers. Accordingly, it is recommended that, in general, only one divider from a laboratory be submitted to the Bureau for calibration and that other dividers be calibrated by a comparison method using it as a standard.

Item	Description	Fee
201.601a	Determination of the ratio and phase angle of an inductive voltage divider for each setting of each of the three highest decades (all decades except the one under test being set to 0) and for two arbitrary settings of all decades at one frequency (100, 400, or 1,000 c/s) and with an input voltage not exceeding 150 v rms	$115.00
201.601z	Determinations of the ratios and phase angles of resistive or capacitive voltage dividers and of inductive voltage dividers beyond those covered in 201.601a are handled on a special test basis, and advance arrangements must be made. Fees will be charged dependent upon the nature of the test.	

201.602 Voltage transformers.

(a) Acceptance: The Bureau normally accepts voltage transformers for calibration only if they are suitable for use as reference standards. Results of tests at or near 60 c/s will normally be reported to 0.01 percent in ratio and 1 min in phase angle.

(b) Test information: Tests cannot be started until information is furnished concerning the following test conditions: (1) test frequency, (2) secondary test voltages, (3) secondary burdens, (4) ranges to be tested.

(c) Transformer burdens: The ratio and phase angle of a voltage transformer vary linearly with secondary current under conditions of constant voltage, frequency, and power factor within its rating. Hence, if values of ratio and phase angle are determined on open circuit (zero burden) and at one burden having a particular power factor, values at other current burdens with the same power factor (and at the same voltage and frequency) can be found by linear interpolation. If the ratio and phase angle of a voltage transformer are known both on open circuit (zero burden) and at a single unity power-factor burden, the ratio and phase angle for any burden within its rating at any power factor (at the same voltage and frequency)

can be computed with sufficient accuracy for many measurement purposes by the following formulas:

$$F=F_0+\frac{I}{I_1}[(F_1-F_0)\cos\Phi+(\gamma_0-\gamma_1)\sin\Phi],$$

and

$$\gamma=\gamma_0+\frac{I}{I_1}[(F_1-F_0)\sin\Phi-(\gamma_0-\gamma_1)\cos\Phi],$$

where I_1 and I are the secondary currents at the known unity power factor burden and the desired burden, respectively; F_0, F_1, and F are the ratio correction factors at zero burden, the known unity power-factor burden, and the desired burden, respectively; γ_0, γ_1, and γ are the corresponding phase angles in radians; and cos Φ is the power factor of the desired burden (Φ being taken as positive for inductive burdens). The following conversion factors apply:

1 minute=0.000291 radian
1 radian=3438 minutes

The "standard burdens" of the ASA Standard for Instrument Transformers (C57.13) are for rating purposes only, and are not recommended for use as test burdens in calibrating a voltage transformer for use as a reference standard. Values of ratio and phase angle at any ASA burden can be computed with sufficient accuracy for rating purposes by using the above formulas. The test burdens recommended are stated in items 201.602a, b, or c below. In these items, the instrument burden "to be specified by the user" should preferably be the burden with which the transformer will be used as a reference standard, in the test circuit, and may be stated either in terms of volt-amperes and power factor at a specified voltage and frequency, or the resistance and reactance of the test circuit elements.

(d) Test voltages: When a secondary burden of fixed impedance is used, the ratio and phase angle of a well-designed voltage transformer are nearly independent of the secondary voltage within its normal operating range. Hence, tests at a single voltage are sufficient unless the transformer is to be operated over an extended voltage range. In extended-range operation the variations of ratio factor and phase angle with voltage are identical for any constant-impedance burden. Hence, it should be sufficient to make ratio and phase-angle determinations at the extremes of the expected voltage-range of operation and at one or perhaps two intermediate voltage points on one burden (preferably zero burden). Tests at all additional burdens need be made at only a single voltage.

(e) Multirange transformer: When multiple ranges are provided by series-parallel primary connections, the ratio correction factors and phase angles (for constant secondary voltage, burden, and frequency) are practically identical for all ranges so obtained. (Hence a single determination on each range after the first serves to completely define the transformer performance when the added ranges are obtained by primary series-parallel combinations.) When multiple ranges are obtained by tapping a portion of one of the windings, or by secondary series-parallel combinations, the ratio correction factors and phase angles are not necessarily the same on the various ranges.

(f) Fuses: It is recommended that voltage transformers intended as reference standards be used without fuses, because fuse resistance affects both ratio and phase angle values so that fuse deterioration or replacement may alter the values. When a fused transformer is submitted, tests with the fuses in place will be made only if this is specifically requested by the customer.

(g) Tests at 400 c/s: Ratio and phase angle determinations at 400 c/s can be made up to 9,000 v. Results of such tests will normally be reported to 0.03 percent in ratio and 3 min in phase angle.

(h) Recalibration: The ratio and phase angle of a voltage transformer for a given burden, voltage, and frequency should not change significantly with time unless the transformer is damaged. Once stability has been demonstrated, a transformer should not require recalibration at intervals less than five years.

(i) Shipment: Heavy transformers should be shipped in wooden boxes and held in place, if necessary, by checks or cleats. Large transformers, especially those having oil-filled iron cases, should be crated separately and arranged, whenever possible, so that the terminals can be made accessible for tests without removing the entire crate. The tops of boxes should be marked "this side up." Large transformers (those more than 12 ft high including crating, or weighing more than 6,000 lb) require special handling; advance arrangements, including provision for delivery *inside* the laboratory, must be made.

Item	Description	Fee
201.602a–1	Determinations of the ratio and phase angle of a voltage transformer at one frequency (25, 50, or 60 c/s), one range, and one secondary voltage, with not more than four values of secondary burden; namely, those giving zero, half, and full rated noninductive load at rated voltage, and with one instrument burden of approximately unity power factor to be specified by the user; primary voltage not to exceed 25,000 v	$86.00
201.602a–2	As in a–1 except primary voltage greater than 25,000 v but not to exceed 100,000 v	120.00
201.602b	Determination of ratio and phase angle at one value of secondary voltage on an additional range or frequency, and with any of the burdens used in 201.602a	16.00
201.602c	Determination of ratio and phase angle with an additional burden (already used in 201.602a) and with the same combination of range, frequency, and voltage used in 201.602b	14.00
201.602d	Determination of ratio and phase angle at an additional burden of approximately unity power factor other than those used in 201.602a	40.00
201.602e	Determination of ratio and phase angle at an additional value of secondary voltage on the same combination of range, frequency, and burden used in 201.602a, b, or c	8.00
201.602z	For tests of voltage transformers at other frequencies, with primary voltage greater than 100,000 v, or with other than unity power factor burdens, and for other special tests not covered by the above schedule, advance arrangements must be made. Fees will be charged depending on the nature of the test. At 400 c/s, test fees are approximately double those at 60 c/s.	

201.603 Voltage transformer comparators.

Item	Description	Fee
201.603z	Calibrations of voltage transformer comparators are handled on a special test basis; however, advance arrangements need not be made. Fees will be charged dependent upon the nature of the calibration required.	

201.604 Kilovoltmeters.

Item	Description	Fee
201.604a	Calibration of kilovoltmeters at five scale points on one range using 60 c/s alternating voltage (up to 60 kv)	$80.00
201.604b	Calibration of kilovoltmeters at five scale points on one range using direct voltage of one polarity to ground (up to 60 kv)	80.00
201.604c	Calibration at one scale point on an additional range (up to 60 kv) for 201.604a or b	21.00
201.604d	Calibration of each additional scale point on one of the ranges calibrated under 201.604a, b, or c	7.00
201.604z	For calibration at voltages above 60 kv, advance arrangements must be made. Fees will be charged dependent upon the nature of the calibration required.	

High-Frequency Region

201.800 (a) General: In the high-frequency region of approximately 30 kc/s to 300 Mc/s and higher, the Electronic Calibration Center, Boulder Laboratories, is equipped to calibrate standards of voltage, power, immittance, attenuation, and field strength. These standards are limited at present to those designed for cw measurements and having coaxial terminals (usually Type N connectors). No general provisions have yet been made for standards with balanced transmission-line terminals.

Stable rf power sources and detectors are required to perform such measurements. This is accomplished by use of crystal-controlled rf power sources and receivers. Rf power sources have power stabilization circuits that provide a power output constant to within 0.1 percent or better over periods of one hour or more. Special low-noise, crystal-controlled receivers meet the exacting requirements to monitor or detect these signals. In using standards at high frequencies it is often desirable, and even necessary, to duplicate these conditions.

Calibration services for high-frequency standards with coaxial connectors are performed at the fixed frequencies of 30, 100, and 300 kc/s, and 1, 3, 10, 30, 100, 300, and 1000 Mc/s. Calibrations are available at other frequencies for some standards, as well as continuous frequency coverage up to 10 Gc/s for certain calibrations, but usually with less accuracy.

Connectors limit the accuracy of measurements in the high-frequency region to some extent. To avoid instability from this cause, precision connectors should be used on interlaboratory standards. In the case of Type N connectors, certain mechanical dimensions should fall within tolerances specified by the Armed Services Electro-Standards Agency (ASESA) in Procurement Specification MIL–C–71. If dimensions fall outside the specified tolerances, there is a possibility of damaging the mating connectors on interlaboratory standards and NBS working standards. Critical dimensions of Type N connectors are indicated on drawings in the brochure entitled "Facilities and Services of the Electronic Calibration Center." This brochure may be obtained from the Electronic Calibration Center, National Bureau of Standards, Boulder, Colo., 80310.

(b) Fees: The fees to be chargedf or the following calibration services performed at the Boulder Laboratories are not fixed at this time, but estimates will be furnished on request to those who plan to submit standards for calibration. If it becomes apparent that the estimated cost of calibration will be exceeded by more than 10 percent, notification will be made by the Electronic Calibration Center, before further work is done.

201.810 Rf, rf–d-c voltmeters, and thermal converters in the frequency range of 30 kc/s to 400 Mc/s; from 0.2 v to 300 v. Ordinarily instruments equally suitable for use on d-c and rf will be calibrated only for rf–d-c difference by the procedure of item 201.810a, since periodic calibrations can be made by the user on reversed direct current. Such reversed d-c calibrations will be made at the Bureau only under unusual circumstances and by advance arrangement. Instruments suitable for use only on rf will be given rf calibrations by the procedures of items 201.810a, b. Instruments which respond to average or peak values or which are not in ASA accuracy class ¼ percent or better are not usually accepted for calibration below 30 Mc/s.

Item	Description	Fee
201.810a	Determination of voltage at 30, 100, 300 kc/s, 1, 3, 10, 30, and 100 Mc/s from 0.2 to 300 v	(*)
201.810b	Determination of voltage at 300, 400, 500, 700, and 1000 Mc/s from 0.2 to 20 v	(*)
201.810z	Special calibrations not covered by the above schedule	(*)

*See 201.800 (b) Fees.

201.811 Rf voltmeters and signal sources in the frequency range of 30 kc/s to 1000 Mc/s, from 1 μv to 0.1 v. The Bureau normally accepts for calibration only high-quality voltmeters suitable for use as interlaboratory standards. These instruments should have a stability of one percent or better and an accuracy of three percent or better. Rf voltmeters will be calibrated by the procedures of items 201.811a, b. The Bureau usually accepts only signal sources (signal generators) high enough in quality to be considered as interlaboratory standards. If these instruments are equally suitable for use on d-c and rf, they will be calibrated for rf–d-c difference by the procedures of items 201.811a, b, c. Signal sources suitable for use only on rf will be calibrated by the procedures of items 201.811a, c.

Item	Description	Fee
201.811a	Determination of voltage for voltmeters and signal sources from 30 kc/s to 400 Mc/s, from 1 μv to 0.1 v	(*)
201.811b	Determination of voltage for voltmeters from 400 to 1000 Mc/s, from 100 μv to 0.1 v	(*)
201.811c	Determination of voltage for signal sources from 30 kc/s to 900 Mc/s, from 100 μv to 0.1 v	(*)
201.811z	Special calibrations not covered by the above schedule	(*)

*See 201.800 (b) Fees.

201.820 Rf calorimeters, 30 kc/s to 400 Mc/s.

(a) For maximum calibration accuracy, interlaboratory rf calorimeters should repeat readings to one percent or better with a constant power input.

(b) At present only rf calorimeters utilizing Type N connectors for rf power input can be calibrated. Refer to 201.800 for special requirements for Type N connectors used on interlaboratory standards.

Item	Description	Fee
201.820a	Calibration of rf calorimeter at one frequency at 100 and 300 kc/s; 1, 3, 10, and 30 Mc/s; and at one power level from 0.001 to 200 w	(*)
201.820b	Calibration of rf calorimeter at one frequency at 100, 200, 300, and 400 Mc/s; at one power level from 0.001 to 100 w	(*)
201.820c	Each additional power level at the same frequency	(*)
201.820z	Special calibrations not covered by the above schedule	(*)

*See 201.800 (b) Fees.

201.830 Immittance, 30 kc/s to 1 Gc/s.

(a) Maximum accuracy can be achieved only in the case of instruments and components equipped with connectors having a plane of reference directly compatible with the Bureau system with no necessity for special adapters. In the interest of preserving higher calibration accuracies, coaxial connectors should be utilized on standard instruments and components wherever possible.

(b) Power applied to any under test will normally not exceed 1 w. Where caution in this respect is necessary it should be clearly stated in the calibration request. All calibrations described in this section are performed under ambient conditions of approximately 23 °C and 50 percent relative humidity.

Item	Description	Fee
201.830a–1	Two-terminal impedance measurement at one point in the frequency range 30 to 400 kc/s, 0 to 10,000 ohms resistance, and 0 to 1100 μh inductance	(*)
201.830a–2	Each additional point within the limits in item 201.830a–1	(*)
201.830b–1	Two-terminal impedance measurement at one point in the frequency range 30 kc/s to 1 Mc/s, 0 to 1000 ohms resistance, and 0 to 110 μh inductance	(*)
201.830b–2	Each additional point within the limits in item 201.830b–1	(*)
201.830c–1	Two-terminal admittance measurement at one point in the frequency range 30 kc/s to 1 Mc/s, 0 to 1100 μmho conductance, and 0 to 1100 pf capacitance	(*)
201.830c–2	Each additional point within the limits in item 201.830c–1	(*)
201.830d–1	Two-terminal admittance measurement at one point in the frequency range 5 to 250 Mc/s, 0 to 50 μmho conductance, and 0 to 50 pf capacitance	(*)

*See footnote at end of table.

Item	Description	Fee
201.830d–2	Each additional point within the limits in item 201.830d–1	(*)
201.830e–1	Two-terminal impedance measurement of coaxial components at frequencies from 50 Mc/s to 1 Gc/s, within the ranges 0.5 to 5000 ohms for magnitude and 0 to 90° for phase angle	(*)
201.830e–2	Each additional point within the limits in item 201.830e–1	(*)
201.830f–1	Q-Standard calibration in the frequency range 50 kc/s to 45 Mc/s, 0 to 1000 for effective Q, and 30 to 450 pf for effective resonating capacitance	(*)
201.830z	Special two-terminal immittance calibrations not covered by the above schedule	(*)
201.831a–1	Three-terminal capacitance calibration at 100 kc/s, 465 kc/s, or 1 Mc/s for the following fixed nominal values: 10^{-2}, 10^{-1}, 10^{0}, 10^{1}, 10^{2}, and 10^{3} pf, per frequencey	(*)
201.831b–1	Three-terminal capacitance calibration at 465 kc/s at one point in the range 0.001 to 100 pf	(*)
201.831b–2	Each additional point within the limits in item 201.831b–1	(*)

*See 201.800(b) Fees.

201.840 Dissipative fixed coaxial attenuators.

(a) Dissipative fixed coaxial attenuators are normally calibrated in a system having a characteristic impedance of $50+j0$ ohms. Since the accuracy of the calibration is degraded by any deviation or uncertainty in this characteristic impedance, the types of allowable connectors are limited. Precision connectors having a known plane of reference or the Type N meeting Procurement Specification MIL–C–71 are required. All measurements are made by the substitution method which requires that the connectors used be asexual or the attenuator have a male connector at one port and a female connector at the other port. If an adapter is required to comply with the foregoing, it must be supplied with the attenuator and the combination will be calibrated as one unit. Attenuators having a VSWR of 1.30 or greater at either port are not acceptable.

(b) Maximum power to any attenuator will not exceed 20 mw unless prior arrangements for higher power levels have been made.

Item	Description	Fee
201.840a–1	Measurement of insertion loss of fixed attenuator at one of the following frequencies: 1, 10, 30, 60, 100, and 30 Mc/s. Range: 0 to 100 db	(*)

*See footnote at end of table.

Item	Description	Fee
201.840a–2	Each additional attenuator at the same frequency and over the same range as item 201.840a–1	(*)
201.840b–1	Measurement of insertion loss of fixed attenuator at any frequency between 300 Mc/s and 8 Gc/s. Range: 0 to 60 db	(*)
201.840b–2	Each additional attenuator at the same frequency and over the same range as item 201.840b–1	(*)
201.840z	Special calibrations not covered by the above schedule	(*)

*See 201.800(b) Fees.

201.841 Dissipative variable coaxial attenuators.

(a) These attenuators are calibrated in accordance with item 201.840 except that the zero or other specified setting of the attenuator is used as the reference. Because attenuation difference only is measured, both ports may have the same connector.

(b) Variable attenuators must have a repeatability of setting better than 0.1 db; incremental attenuators must have a repeatability of 0.01 db or better.

Item	Description	Fee
201.841a–1	Measurement of one increment on dissipative variable attenuator or at one of the following frequencies: 1, 10, 30, 60, 100, and 300 Mc/s. Range: 0 to 100 db	(*)
201.841a–2	Each additional increment at the same frequency and over the same range as item 201.841a–1	(*)
201.841b–1	Measurement of one increment on a dissipative variable attenuator at any frequency between 300 Mc/s and 8 Gc/s. Range: 0 to 60 db	(*)
201.841b–2	Each additional increment at the same frequency and over the same range as item 201.841b–1	(*)
201.841z	Special calibrations not covered by the above schedule	(*)

*See 201.800(b) Fees.

201.842 Waveguide below-cutoff (piston) attenuators.

(a) Waveguide below-cutoff attenuators are normally calibrated in a system having a characteristic impedance of $50+j0$ ohms. As only attenuation difference measurements are made on this type of attenuator, Type BNC, C, TNC, etc., connectors are acceptable but precision type connectors are preferred.

(b) An insertion loss measurement at the attenuator zero setting can be made. Maximum power to any attenuator will not exceed 20 mw unless prior arrangements for higher power levels have been made.

(c) Calibrations are performed at the following frequencies: 1, 10, 30, 60, 100, and 300 Mc/s.

Item	Description	Fee
201.842a–1	One increment on a waveguide below-cutoff attenuator at one of the following frequencies: 1, 10, 30, 60, 100, and 300 Mc/s. Range (including initial insertion loss): up to 110 db	(*)
201.842a–2	Each additional increment at the same frequency and over the same range as 842a–1	(*)
201.842z	Special calibrations not covered by the above schedule	(*)

*See 201.800(b) Fees.

201.843 Coaxial fixed directional couplers. Fixed directional couplers are calibrated in accordance with item 201.840. Terminations must be supplied for any arm not used during a measurement.

Item	Description	Fee
201.843a–1	Single insertion loss measurement between any two arms of a coaxial fixed directional coupler at one of the following frequencies: 1, 10, 30, 60, 100, and 300 Mc/s. Range: 0 to 100 db.	(*)
201.843a–2	Each additional insertion loss measurement between any two arms at the same frequency and over the same range as item 201.843a–1.	(*)
201.843b–1	Single insertion loss measurement between any two arms at any frequency between 300 Mc/s and 8 Gc/s. Range: 0 to 60 db.	(*)
201.843b–2	Each additional insertion loss measurement between any two arms at the same frequency and over the same range as item 201.843b–1.	(*)
201.843z	Special calibrations not covered by the above schedule	(*)

*See 201.800(b) Fees.

201.844 Coaxial variable directional couplers.

(a) Coaxial variable directional couplers are calibrated in accordance with item 201.841. Terminations must be supplied for any arm not used during a measurement.

(b) The change in coupling to the sidearm relative to the minimum setting on the device is normally measured.

Item	Description	Fee
201.844a–1	Single coupling increment between input and variable arm of coaxial variable directional coupler at one of the following frequencies: 1, 10, 30, 60, 100, and 300 Mc/s. Range (including initial coupling loss): up to 110 db.	(*)
201.844a–2	Each additional increment at the same frequency, and over the same range as item 201.844a–1.	(*)
201.844b–1	Same measurement as in item 201.844a–1 at any frequency between 300 Mc/s and 8 Gc/s. Range (including initial coupling loss): up to 60 db.	(*)
201.844b–2	Same measurement as in item 201.844a–2 at the same frequency and over the same range as item 201.844b–1.	(*)
201.844z	Special calibrations not covered by the above schedule	(*)

*See 201.800(b) Fees.

201.850 Field strength meters, 30 c/s to 1000 Mc/s. Field strength standards and field strength meters are calibrated in terms of cw signals in the frequency range from 30 c/s to 1000 Mc/s. Loop antennas are calibrated in the frequency range from 30 c/s to 30 Mc/s, and horizontally polarized dipole antennas are calibrated from 30 to 1000 Mc/s. The magnitude of the calibrating fields varies from approximately 25 to 200 mv/m for loop antennas, and approximately 50 mv/m for dipole antennas.

The internal characteristics of field strength meters, such as the overall linearity of the receiver, accuracy of the signal input attenuators, and the accuracy of the receiver as a two-terminal rf voltmeter can be measured at frequencies from 30 c/s to 1000 Mc/s.

When field strength standards or meters are submitted for calibration an instruction manual and all accessories should be included, and the instrument should be in excellent operating condition.

Item	Description	Fee
201.850a–1	Calibration of loop antenna at one frequency, 30 c/s to 30 Mc/s	(*)
201.850a–2	Calibration of loop antenna at frequencies additional to item 201.250a–1, 30 c/s to 1 Mc/s	(*)
201.850a–3	Calibration of loop antenna at frequencies additional to item 201.850a–1, 1 to 30 Mc/s	(*)
201.850z	Special calibrations not covered by the above schedule	(*)
201.851a–1	Calibration of dipole antenna at one frequency, 30 to 1000 Mc/s	(*)

*See footnote at end of table.

Item	Description	Fee
201.851a–2	Calibration of dipole antenna at frequencies additional to item 201.851a–1, 30 to 400 Mc/s	(*)
201.851a–3	Calibration of dipole antenna at frequencies additional to item 201.851a–1, 400 to 1000 Mc/s	(*)
201.851z	Special calibrations not covered by the above schedule	(*)
201.852a–1	Calibration of input attenuators at one frequency, initial step	(*)
201.852a–2	Calibration of additional steps of input attenuator in addition to item 201.852a–1	(*)
201.852b–1	Calibration of the overall linearity of receiver and output circuit at one frequency and one attenuator setting, initial point	(*)
201.852b–2	Calibration of overall linearity of receiver at other points in addition to item 201.852b–1	(*)
201.852c–1	Calibration of the receiver as a two-terminal rf voltmeter, 1 to 10,000 μv, 0 to 400 Mc/s, at one frequency	(*)
200.852c–2	Calibration of the receiver as a two-terminal rf voltmeter at other frequencies additional to item 201.852c–1, 0 to 400 Mc/s	(*)
201.852c–3	Calibration of receiver as a two-terminal rf voltmeter at other frequencies additional to item 201.852c–1, 400 to 1000 Mc/s	(*)
201.852z	Special calibrations not covered by the above schedule	(*)

*See 201.800(b) Fees.

Microwave Region

201.900 General.

(a) Microwave calibration services presently available include measurements in power, impedance, frequency, attenuation, and noise. The frequency range covered for each of the measurements is given below.

In performing microwave calibrations, a considerable amount of time usually is needed to prepare the system for measurement operation. Much of this preparation is related to the adjustment of the system to the frequency of operation selected for the calibration. Time and cost often can be reduced by minimizing the number of times the operating frequency of the calibration system must be readjusted. To help in achieving this reduction in costs, a list of suggested calibration frequencies is presented in the following table. These frequencies are suggested for use in connection with this schedule and for interlaboratory standards utilizing terminations consisting of the standard waveguide sizes given below in the table of suggested calibration frequencies. It should be emphasized that the suggested frequencies are primarily for economy and for convenience to those requesting calibrations. In general the calibration

instrumentation for the microwave region is intended to provide complete and continuous frequency coverage as appropriate for the various waveguide sizes. Those having need for calibrations at other than suggested frequencies can be accommodated.

EIA waveguide designation	Frequency range, Gc/s	Suggested calibration frequencies Gc/s		
		No. 1	No. 2	No. 3
WR 284	2.60– 3.95	2.85	3.25	3.55
WR 187	3.95– 5.85	4.35	4.90	5.25
WR 137	5.85– 8.20	6.45	7.00	7.40
WR 112	7.05–10.0	7.75	8.50	9.00
WR 90	8.20–12.4	9.00	9.80	11.2
WR 62	12.4 –18.0	13.5	15.0	17.0
WR 42	18.0 –26.5	19.8	22.0	23.8
WR 28	26.5 –40.0	29.0	33.0	37.0

(b) Fees: The fees to be charged for the following calibration services performed at the Boulder Laboratories are not fixed at this time, but estimates will be furnished on request to those who plan to submit standards for calibration. If it becomes apparent that the estimated cost of calibration will be exceeded by more than 10 percent, notification will be made by the Electronic Calibration Center, before further work is done.

201.910 Continuous low-level, power measurement of waveguide bolometer units and bolometer-coupler units.

(a) Power measurements are made on barretter-type bolometer units having nominal resistance of either 100 or 200 ohms at a bias current between 3.5 and 10 ma, and on thermistor-type bolometer units having a nominal resistance of either 100 or 200 ohms at a bias current between 5 and 15 ma. Bolometer units should be of the fixed tuned or untuned broadband type.

(b) Power measurements are made on bolometer units at power values from 0.1 to 10 mw.

(c) Power measurements are made on bolometer-coupler combinations having coupling ratios from 3 to 20 db. A bolometer unit of the fixed tuned or untuned broadband type should be permanently attached to the side arm of the coupler. The three-port directional coupler should have good design features with a directivity of 40 db or greater and a VSWR no greater than 1.05 for the input and output ports of the main arm of the coupler.

(d) Effective efficiency, η_{eu}, for bolometer units is defined as the ratio of the substituted d-c power in the bolometer element to the microwave power dissipated within the bolometer unit.

(e) Calibration factor for bolometer units is defined as the ratio of the substituted d-c power in the bolometer unit to the microwave power incident upon the bolometer unit.

(f) Calibration factor for bolometer-coupler units is defined as the ratio of the substituted d-c power in the bolometer unit on the side arm of the directional coupler to the microwave power incident upon a nonreflecting load attached to the output port of the main arm.

Item	Description	Fee
	Measurement of effective efficiency of bolometer unit at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.910a–1	WR90 (8.2–12.4 Gc/s)	(*)
201.910a–2	WR62 (12.4–18.0 Gc/s)	(*)
	Measurement of calibration factor of bolometer unit at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.910b–1	WR90 (8.2–12.4 Gc/s)	(*)
201.910b–2	WR62 (12.4–18.0 Gc/s)	(*)
	Measurement of calibration factor of bolometer-coupler unit at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.910c–1	WR90 (8.2–12.4 Gc/s)	(*)
201.910c–2	WR62 (12.4–18.0 Gc/s)	(*)
201.910z	Special calibrations not covered by the above schedule	(*)

*See 201.900(b) Fees.

201.911 Continuous low-level power measurement of waveguide dry calorimeters.

(a) Power measurements are made on dry calorimeters at power values from 10 to 100 mw.

Item	Description	Fee
201.911a–1	Measurement of output voltage versus input microwave power for dry calorimeter at a single frequency of WR90 waveguide (8.2–12.4 Gc/s) terminated with standard waveguide connectors.	(*)
201.911a–2	Each additional power value at the same frequency as Item 201.911a–1.	(*)
201.911z	Special calibrations not covered by the above schedule	(*)

*See 201.900(b) Fees.

201.920 Reflection coefficient magnitude measurement on waveguide reflectors (mismatches).

(a) Reflection coefficient measurements are made on reflectors producing a reflection coefficient magnitude in the range of 0.025 to 1.0.

(b) Reflectors must be fitted with standard types of waveguide flanges. The face of these flanges should be machined flat and smooth and should not contain protrusions or indentations. The connecting holes of the flange should be symmetrically and accurately alined to the rectangular waveguide opening.

Item	Description	Fee
201.920a–1	Measurement of reflection coefficient magnitude of reflector at a single frequency of WR 90 waveguide (8.2–12.4 Gc/s) terminated with standard waveguide connectors	(*)
201.920z	Special calibrations not covered by the above schedule	(*)

*See 201.900 (b) Fees.

201.930 Frequency measurement on cavity wavemeters.

(a) Frequency measurements are made on fixed or variable cavity wavemeters of either the reaction (one-port) type or the transmission (two-port) type.

(b) Frequency measurements are made on fixed or variable cavity wavemeters having coaxial terminals with Type N connectors (male or female) in the frequency range of 100 Mc/s to 10 Gc/s.

(c) Frequency measurements are made on fixed or variable cavity wavemeters having standard rectangular waveguide terminals with standard type waveguide terminals in the frequency range of 2.6 to 75 Gc/s.

Item	Description	Fee
201.930a	Measurement of resonant frequency of fixed cavity wavemeter	(*)
201.930b	Setting of adjustable cavity wavemeter at prescribed resonant frequency	(*)
201.930c–1	Calibration of dial setting versus resonant frequency of variable cavity wavemeter at initial prescribed frequency	(*)
201.930c–2	Calibration of dial setting versus resonant frequency of variable cavity wavemeter at each prescribed frequency additional to the initial frequency and on the same wavemeter as 201.930c–1	(*)
201.930z	Special calibrations not covered by the above schedule	(*)

*See 201.900 (b) Fees.

201.940 Attenuation difference measurements on variable attenuators.

(a) Attentuation difference measurements are made on step or continuously variable attenuators usually with the zero dial setting used as the reference position.

(b) Attenuation measurements are made for attenuation values from 0 to 50 db. This range of attenuation values can be extended to 70 db in some frequency ranges.

(c) Variable attenuators should have a repeatability of dial setting better than ±0.1 db.

(d) Variable attenuators should have a VSWR less than 1.1 at each waveguide port.

Item	Description	Fee
	Measurement of attenuation difference of direct-reading variable attenuator at an initial prescribed dial setting at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.940a–1	WR284 (2.60–3.95 Gc/s)	(*)
201.940a–2	WR187 (3.95–5.85 Gc/s)	(*)
201.940a–3	WR137 (5.85–8.2 Gc/s)	(*)
201.940a–4	WR112 (7.05–10.0 Gc/s)	(*)
201.940a–5	WR90 (8.2–12.4 Gc/s)	(*)
201.940a–6	WR62 (12.4–18.0 Gc/s)	(*)
201.940a–7	WR42 (18.0–26.5 Gc/s)	(*)
201.940a–20	Measurement of attenuation difference of direct-reading variable attenuator at each prescribed dial setting additional to the initial dial setting at the same frequency and on the same attenuator as 201.940a–1 to 201.940a–7.	(*)
	Calibration of dial setting versus attenuation difference for indirect-reading variable attenuator at an initial prescribed attenuation difference value at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.940b–1	WR284 (2.60–3.95 Gc/s)	(*)
201.940b–2	WR187 (3.95–5.85 Gc/s))	(*)
201.940b–3	WR137 (5.85–8.2 Gc/s)	(*)
201.940b–4	WR112 (7.05–10.0 Gc/s)	(*)
201.940b–5	WR90 (8.2–12.4 Gc/s)	(*)
201.940b–6	WR62 (12.4–18.0 Gc/s)	(*)
201.940b–7	WR42 (18.0–26.5 Gc/s)	(*)

* See footnote at end of table.

Item	Description	Fee
201.940b–20	Calibration of dial setting versus attenuation difference for indirect-reading variable attenuator at each prescribed attenuation difference value additional to the initial attenuation difference value at the same frequency and on the same attenuator as 201.940b–1 to 201.940b–7.	(*)
201.940z	Special calibrations not included in the above schedule	(*)

*See 201.900(b) Fees.

201.941 Insertion loss measurements on fixed attenuators.

(a) Insertion loss measurements are made on fixed two-port attenuators.

(b) Insertion loss measurements are made for insertion loss values from 0 to 50 db. This range of attenuation values can be extended to 70 db in some frequency ranges.

(c) Fixed attenuators should have a VSWR less than 1.1 at each waveguide port.

Item	Description	Fee
	Measurement of insertion loss of fixed attenuator at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.941a–1	WR284 (2.60–3.95 Gc/s)	(*)
201.941a–2	WR187 (3.95–5.85 Gc/s)	(*)
201.941a–3	WR137 (5.85–8.2 Gc/s)	(*)
201.941a–4	WR112 (7.05–10.0 Gc/s)	(*)
201.941a–5	WR90 (8.2–12.4 Gc/s)	(*)
201.941a–6	WR62 (12.4–18.0 Gc/s)	(*)
201.941a–7	WR42 (18.0–26.5 Gc/s)	(*)
201.941z	Special calibrations not included in the above schedule	(*)

*See 201.900(b) Fees.

201.950 Effective noise temperature measurements on noise sources.

(a) Effective noise temperature measurements are made on waveguide noise sources (usually a gas-discharge tube) under conditions of continuous, unmodulated operation in the range 900 to 300,000 °K (excess noise ratio range 2.5 to 30 db).

(b) The direct current required for normal operation of the gas-discharge tube should not exceed 300 ma but should be sufficient to prevent excessive plasma oscillations.

(c) The waveguide noise source must have an input VSWR no greater than 1.7.

(d) The gas-discharge tube should be secure in the mount, and the output port of the unit should be terminated with a matched load.

Item	Description	Fee
201.950a–1	Measurement of effective noise temperature of noise source in WR90 waveguide at a single frequency selected from 9.0, 9.8, and 11.2 Gc/s	(*)
201.950z	Special calibrations not covered by the above schedule	(*)

*See 201.900(b).

Part 202—Metrology

Photometry and Colorimetry

Sec.

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202.182 Photometric instruments and accessories
202.183 Miscellaneous photometric measurements and tests
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Photometry and Colorimetry

202.181 Lamp standards of candlepower.

(a) The Bureau is prepared to standardize incandescent filament lamps which have been properly seasoned, or to season and standardize lamps when necessary, or to furnish lamps (of the more common types and sizes) that have been seasoned and standardized, the respective fees being as given in the test fee schedule in this section.

(b) A normal incandescent lamp when operated at constant voltage usually increases slightly in candlepower for a short time, the length of which depends upon the temperature of the filament. A relatively stable period is then reached, after which there is a progressive drop in the candlepower. Therefore, in order that a lamp may be useful as a photometric standard, it should be seasoned by a preliminary burning sufficient to bring it to the stable state. This seasoning is usually done by operating the lamp at a voltage somewhat higher than the normal operating voltage of the lamp.

(c) Lamps with coiled filaments are not usually satisfactory as standards unless they have been specially constructed for this purpose. In particular, lamps of this type are not suitable for standards of horizontal candlepower unless they are of the monoplane-filament projection type. This type of gas-filled lamp with clear bulb (items 202.181a, b, and c) has been found to be satisfactory as a standard of horizontal candlepower when standardized with a diaphragm in front of the lamp. This diaphragm is slightly larger than the filament and allows only the light coming directly from the filament to reach the photometer. In addition, great care must be taken to orient such standards properly because their candlepower varies appreciably

with change of angle around both a vertical axis and a horizontal axis. Recently made available are gas-filled standards of horizontal candlepower in tubular, inside-frosted bulbs with medium-bipost bases (items 202.181d, e, f, and g), which are calibrated and used without a diaphragm and for which accurate orientation has been found to be much less critical. These inside-frosted lamps are recommended for use where reproducibility of candlepower to 1 percent or better is required.

(d) When lamps are submitted for standardization it is necessary that they be accompanied by a statement as to whether they have been seasoned. If they have been seasoned, the voltage at which they were burned and the number of hours should be given if known. It should be stated also whether they are to be standardized at a given voltage or current at the fees listed below or at a given candlepower or color temperature at an increased fee. In the reports which are issued with standard lamps, the voltage and the corresponding current and candlepower are given. The Bureau cannot guarantee the permanence of these values, since all lamps change gradually with use.

Item	Description	Fee
	Incandescent lamps issued from stock as standards of luminous intensity:	
202.181a	Clear bulb, approximately 120–v lamps, horizontal candles in a specified direction, screw base, 100–w size, calibrated at 105 v, one lamp each	$35.00
202.181b	Same, 250-w size, one lamp each	40.00
202.181c	Same, 500-watt size, one lamp each	42.00
202.181d	Inside-frosted, T–20 bulb, approximately 120-v lamps, horizontal candles in a specified direction, medium-bipost base, 100-w size, calibrated at 110 v, one lamp each	47.00
202.181e	Same, 300-w size, one lamp each	49.00
202.181f	Same, 500-w size, one lamp each	51.00
202.181g	Same, 1,000-w size, one lamp each	55.00
202.181k	Additional fee for calibrating lamps on items 202.181a to g inclusive at voltages other than those listed, each lamp	11.00
	Standardization of seasoned incandescent lamps submitted for standardization, approximately 120-v lamps, medium-screw, mogul-screw, or medium-bipost base:	
202.181l	Clear or inside-frosted bulb, horizontal candles in a specified direction, 100- to 1,000-w sizes, one lamp each	46.00
202.181n	Same as item 202.181l, each additional lamp of same size submitted at the same time for calibration at approximately the same voltage	31.00
202.181o	Seasoning of incandescent lamps for standardization, and preliminary measurements, 10 to 200 w, each lamp	7.00

Item	Description	Fee
202.181p	Same, other sizes and types up to 5,000 w and all series-burning lamps	$9.00
	Standardization of seasoned fluorescent and mercury lamps submitted for calibration:	
202.181q	Determination of luminous flux (lumens) of "white," "cool white," or "daylight" fluorescent lamps, one lamp	47.00
202.181r	Same, each additional lamp	23.00
202.181s	Determination of luminous flux (lumens) of mercury vapor lamps, one lamp	63.00
202.181t	Same, each additional lamp	35.00
202.181z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.182 Photometric instruments and accessories.

Item	Description	Fee
202.182f	Standard of luminous directional transmittance (approximately 0.5 fl/fc) supplied from stock, each	$34.00
202.182z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.183 Miscellaneous photometric measurements and tests.

Item	Description	Fee
202.183a	Determination of luminous transmittance of neutral or colored filter, one sample	$33.00
202.183b	Same, each additional sample of approximately the same transmittance submitted at the same time or at each additional color temperature of illuminant	10.00
202.183z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.184 Rating of incandescent electric lamps.

Item	Description	Fee
	Rating tests on lamps. These are routine photometric rating tests of of the type made initially on lamps to be life-tested, the same standards and equipment being used. The purpose of these tests is to afford a quick check of the photometric values assigned to lamps by various lamp life-test laboratories. Lamp standards of candlepower are issued or calibrated under 202.181.	
202.184a	Rating of incandescent lamps up to 1,000 w, one lamp	$22.00
202.184b	Same, each additional lamp of same size and type	5.00
202.184z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.185 Spectrophotometric standards.

NOTE on item a. Transmittances of these disks at wavelengths from 365 to 390 nm (nanometer, 10^{-9} meter) and from 750 to 1,000 nm will also be determined on request in accordance with item c of fee schedule 202.185. Values will be obtained for a temperature of 25 °C. The effect of change of temperature has not been determined for these glasses outside the range from 390 to 750 nm. It is known, however, that for all four types of glass the temperature effects are very small from 750 to 1,000 nm, probably negligible for the usual room-temperature variations. On the other hand, temperature effects are always large for these kinds of glass when the transmittance curve is decreasing rapidly towards shorter wavelengths, so that increasingly large temperature effects may be expected for these filters in the ultraviolet.

NOTE on items j and k. In the General Electric recording spectrophotometer the design is such that the radiant energy is incident in a slightly diverging beam whose axis is at 6° to the perpendicular to the surface. The specular component of the reflected energy is thus diverted away from the entrance aperture towards a port on the side. This port may be filled with MgO or with a black material, so that the specular component may be respectively "included" in, or (for plane surfaces) "excluded" from, the measurements. This is covered in items j and k.

Only one Vitrolite working standard is needed for the measurement of spectral directional reflectance on the General Electric recording spectrophotometer. This calibrated Vitrolite standard and the samples to be tested are in turn placed at the sample aperture of the integrating spheres, and any highly reflecting substance such as MgO or $MgCO_3$ may be used at the comparison aperture provided the material to be tested does not reflect more than the comparison material. The directional reflectances of the test samples relative to freshly prepared MgO are then obtained by multiplying (at the respective corrected wavelength) the values for these samples read from the curve sheet, by the ratios of (a) the standard Vitrolite values reported to (b) the values for the Vitrolite read from the curve sheet.

Item	Description	Fee
	Standards of spectral transmittance for checking the photometric scale of spectrophotometers; these consist of polished disks of glass, 2 to 3 mm thick and 30 mm in diameter, designated as cobalt blue, copper green, carbon yellow, and selenium orange (copper green filter also available in 25 mm square size); report includes (1) values of transmittance at	

Item	Description	Fee
	25 °C at certain wavelengths from 390 to 750 nm, (2) estimated uncertainty of each value, (3) effect of temperature change on transmittance at each wavelength:	
202.185a	Each disk	$100.00
	Transmittance, 365 to 1,000 nm for standardization purposes. Samples submitted must be in good optical condition. Measurements at room temperature. (If the sample is a disk 29.7±0.2 mm in diameter, the measurements can be made at a specified temperature):	
202.185b	One sample at one wavelength	39.00
202.185c	Each additional wavelength on the same sample	9.00
	Didymium glass standards for checking the wavelength calibration of General Electric recording spectrophotometers; these consist of Corning 5120 glass, 2×2 in., 3.0 mm thick, polished; report includes table of wavelengths of minimum transmittance:	
202.185d	400 to 750 nm, 10 nm slits, each standard	50.00
202.185e	730 to 1,080 nm, 20 nm slits, each standard	50.00
202.185f	For two calibrations on the same glass (items 202.185d and 202.185e), each standard	76.00
	Holmium oxide glass standards for checking the ultraviolet and visible wavelength calibrations of recording spectrophotometers with slit width less than 2 nm; these consist of Corning 3130 glass 2×2 in., 2.5 mm thick, polished; report includes table of wavelengths of minimum transmittance:	
202.185g	240 to 370 nm, each standard	85.00
202.185h	360 to 650 nm, each standard	85.00
202.185i	For two calibrations on the same glass (items 202.185g and 202.185h), each standard	110.00
	Working standards of spectral directional reflectance for use on General Electric recording spectrophotometers with 6° from perpendicular irradiation and diffuse reception; standards consist of white structural Vitrolite glass, 4×4 in., 5/16 in. thick; report includes table of spectral directional reflectances relative to freshly prepared MgO at every 10 nm:	
202.185j	400 to 750 nm, specular component both included and excluded (on same glass), 10 nm slits, each standard	110.00
202.185k	730 to 1,080 nm, specular component both included and excluded (on same glass), 20 nm slits, each standard	110.00

Item	Description	Fee
	Working standards of spectral directional reflectance for use on the Beckman Model DU quartz spectrophotometer with nearly perpendicular irradiation and approximately 45° circular reception; standards consist of white structural Vitrolite glass, 1½×2 in., 1/16 in. thick; report includes table of spectral reflectances relative to freshly prepared MgO at every 10 nm:	
202.185l	380 to 770 nm, each standard	$64.00
202.185m	750 to 1,000 nm, each standard	64.00
202.185n	350 to 1,000 nm, each standard	115.00
202.185z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.186 Spectrophotometric measurements. The tests described in this section are primarily made for informational purposes, and samples so tested should not be accepted as "standards." All measurements are made at room temperature For various types of spectrophotometric standards, see 202.185.

Item	Description	Fee
	Spectral transmittance, 210 to 1,000 nm:	
202.186a	One sample at one wavelength	$43.00
202.186b	Each additional wavelength on the same sample	4.00
202.186c	Each additional sample, each wavelength	4.00
	Spectral directional reflectance relative to MgO, normal irradiation and 45° circular reception, as obtained with the Beckman Model DU spectrophotometer, 254 to 1,000 nm:	
202.186d	One sample at one wavelength	43.00
202.186e	Each additional wavelength on the same sample	4.00
202.186f	Each additional sample, each wavelength	4.00
	Spectral transmittance or transmittancy curves obtained on General Electric recording spectrophotometer, including 100 percent and zero calibration curves and didymium glass curve for checking the wavelength calibration; report includes ozalids of tracings:	
202.186g	Testing a single sample, 400 to 750 nm or 730 to 1,080 nm, with slits approximately 10 nm or 20 nm (respectively) of spectrum, either spectral range.	58.00

Item	Description	Fee
202.186h	Each additional curve or each additional sample	$9.00
202.186i	Same as 202.186g, but with both spectral ranges, 400 to 1,080 nm	80.00
202.186j	Each additional pair of curves or each additional sample	14.00
	Spectral directional reflectance curves obtained on General Electric recording spectrophotometer, including (1) Vitrolite calibration curve for correcting values relative to fresh MgO as 100 percent, (2) zero curve, (3) didymium glass curve for checking the wavelength calibration; report includes ozalids of tracings:	
202.186k	One sample, 400 to 750 nm, or 730 to 1,080 nm, with slits approximately 10 nm or 20 nm (respectively) of spectrum, with specular component of reflected energy included or excluded, either specular range, and either condition of specular reflection	58.00
202.186l	Each additional curve or each additional sample, each curve	9.00
202.186m	Same as 202.186k, but both spectral ranges, 400 to 1,080 nm	80.00
202.186n	Each additional pair of curves or each pair of curves on each additional sample	14.00
202.186o	Reduction of data obtained as in 202.186g to 202.186n, giving table of values of transmittance, transmittancy, or directional reflectance relative to MgO for every 10 nm, for each curve	24.00
202.186z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.187 Colorimetry.

Item	Description	Fee
202.187a	Computing chromaticity coordinates and luminous directional reflectance or transmittance from spectrophotometric data for certain specified light sources, per source per sample	$13.00
202.187b	Computing luminous directional reflectance or transmittance from spectrophotometric data for certain specified light sources, per source per sample	9.00
202.187c	Determination of the Munsell renotation or book notation of a specimen from its daylight reflectance and chromaticity coordinates, each specimen	7.00

Item	Description	Fee
202.187d	Conformity to chromaticity of standard, sample and standard illuminated normally by artificial daylight or by incandescent-lamp light, chromaticity difference expressed in terms of chromaticity coordinates on fundamental colorimetric coordinate system, one sample relative to a standard	$31.00
202.187e	Each additional sample relative to the same standard	7.00
202.187f	Each additional sample relative to an additional standard	12.00
202.187g	Color temperature of 120-v, screw-base incandescent lamp, voltage for specified color temperature, current for neighboring voltage to check permanence, one color temperature, each lamp	34.00
202.187h	Color temperature standard supplied from stock, 100-w, medium-screw base or 500-w mogul-screw base projection type lamp, calibrated for 2,854 °K, one lamp each	34.00
202.187i	Same, calibrated for any one other specified color temperature, one lamp each	37.00
202.187j	Each additional color temperature on the same lamp	13.00
202.187k	Equation giving any color temperature from 2,000 to 2,854 °K, each lamp (fee includes cost of 500-w projection lamp)	85.00
202.187z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.188 Reflectometry. Standards issued: Standards have been prepared for use in the measurement of daylight 45°0° directional reflectance (45° illumination, perpendicular viewing) of paints, paper, textiles, ceramic products, and other opaque materials. The standards are intended for use only with reflectometers designed to measure daylight 45°0° directional reflectance such as the multipurpose reflectometer developed at the Bureau. (Refer to J. Res. NBS **25**, 581 (1940) RP1345.) Standards are available also for the tristimulus colorimetry of reflecting specimens of nearly the same spectral character. A detailed discussion of the method of photoelectric tristimulus colorimetry, its capabilities and limitations, is contained in NBS Circular 429 (1942).[3] The standards are calibrated in terms of the CIE tristimulus values, X, Y, and Z. Information sheets describing these standards more fully are available on request.

Item	Description	Fee
	Standards issued	
	KB chromatic reflectance standards—calibrated for CIE tristimulus values X, Y, Z; 3 × 5 in. plaques in colors commonly called white,	

[3] NBS Circular 429, Photoelectric tristimulus colorimetry with three filters. In NBS Handbook 77, Precision Measurement and Calibration, Vol. III, Optics, Metrology, and Radiation, p. 529 (see pp. 101–102 for price information and order form).

Item	Description	Fee
	bath green, kitchen green, orchid, ivory, maize, bath blue, delphinium blue, royal blue, and red:	
202.188d	One KB chromatic standard	$44.00
202.188e	Each additional KB chromatic standard	17.00
202.188f	Set of 10 KB chromatic standards in above listed colors	138.00
	S chromatic reflectance standards—calibrated for CIE tristimulus values *X*, *Y*, *Z*; 4¼ in. sq with ¼-in., 90-deg fold at each edge; in colors commonly called safety red, aviation orange, safety orange, school bus chrome, safety yellow, safety green, and safety blue:	
202.188g	One *S* chromatic standard	44.00
202.188h	Each additional *S* chromatic standard	17.00
202.188i	Set of 7 *S* chromatic standards in above listed colors	132.00
	Samples or standards submitted for calibration	
202.188z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.189 Opacimetry. Opacity of diffusing glass by contrast-ratio (ratio of luminous directional reflectance with black backing to that with white backing), illumination nearly perpendicular to surface of glass, reception of all reflected flux regardless of angle. Reflectance of white backing taken so as to accord with Bausch & Lomb type photoelectric opacimeter correctly adjusted to read contrast-ratio for thin samples with a white backing reflecting 0.915 relative to MgO (TAPPI test method T425m–36). Diffusing glass rectangles, 5×12 cm, supplied by the Bureau.

Item	Description	Fee
202.189a	Each diffusing-glass opacity standard, opacity between 0.60 and 0.96 as desired	$35.00
202.189b	Set of four diffusing-glass opacity standards, opacities approximately equal to 0.72, 0.79, 0.86, and 0.93	105.00
202.189z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.191 Lovibond glasses. Lovibond red glasses, determination of numeral on the additive (N'') scale established (by Priest and Gibson's adjustment set BS 9940) at the Bureau in 1927, the value given being the effective value when the given red glass is used in combination with a 35-yellow glass, each glass to be engraved with the National Bureau of Standards test number and the numeral found for the glass.

Item	Description	Fee
202.191a	For testing a single red glass	$32.00
202.191b	For each additional red glass	10.00
202.191z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.192 Signal glass limit glasses and IPL calibrating filters.

(a) Railroad, highway (traffic), and aviation signal glasses for use as chromaticity limits or transmittance standards in accord with specifications approved by the cognizant technical association or government agency will be issued when available. The report of calibration includes chromaticity coordinates, luminous transmittance, or both as determined relative to national standards filters for the specified color temperature of source.

(b) Instrument Panel Lighting (IPL) calibrating filters are available in 2-in. polished squares. They have the following designations (approximate chromaticity coordinates for color temperature 2854 °K are shown below in parentheses): NBS 3056 ($x=0.723$, $y=0.277$), NBS 3114 ($x=0.712$, $y=0.288$), NBS 3215 ($x=0.698$, $y=0.302$), and NBS 3648 ($x=0.667$, $y=0.333$). The NBS 3215 filters define the pale limit for airplane red instrument panel lighting and are usually used in pairs; the other types of filters listed are for calibrating photometers used for measuring panel luminance.

Item	Description	Fee
202.192a	Signal limit glasses, each	$100.00
202.192b	IPL calibrating filters, calibrated for chromaticity coordinates and transmittance for 2854 °K, each	56.00
202.192c	Calibration for transmittance at an additional color temperature	10.00
202.192z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.193 Haze standards. Standards are available for checking the accuracy of hazemeters designed to measure haze according to ASTM Method D1003. Standards consist of hazy cellulose acetate sheeting laminated between glass; they are 2-in. squares about ¼ in. thick. Several nominal haze values between 1 and 30 are usually available.

Item	Description	Fee
	Standards issued	
202.193a	One haze standard	$40.00
202.193b	Each additional haze standard ordered at the same time	12.00
202.193c	Set of four haze standards	62.00
	Samples or standards submitted for calibration	
202.193d	One haze sample or standard	24.00
202.193e	Each additional haze sample or standard submitted at the same time	8.00
202.193z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.194 Radiometry.

Item	Description	Fee
202.194a	Eye protective glasses—calibration for transmittance of ultraviolet, visible, and total radiation	$35.00
202.194b	Calibration of radiant energy meter for energy of 2537 Å	35.00
202.194c	Measurement of radiant flux of 2537 Å, from germicidal or sterilamp	35.00
202.194h	Standard of spectral irradiance—quartz iodine lamp seasoned and calibrated for spectral irradiance from 0.25 to 2.6 μ	325.00
202.194z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

Refractometry

202.201 Optical instruments.

Item	Description	Fee
202.201z	Tests of telescopes, microscopes, binoculars, etc., to determine conformance to specifications of resolving power, aperture, alinement of axes, etc. Fees determined by the actual cost of the work.	

202.202 Photographic objectives. The following information is pertinent to the tests a to o in this schedule.

a. This test is applied to photographic objectives that are mounted in a lens barrel or shutter. A visual or a photographic method is used, depending upon the probable use of the lens. The back focal distance determines the lens position with respect to the focal plane for an airplane camera or other fixed focus camera focused for an infinitely distant objective. The equivalent focal length determines the scale factor for the interpretation of aerial photographs.

b. This test is given to the photographic objectives that are to be used in precision copying cameras. The information is used in calibrating the camera scales that enable the user to obtain the proper settings of lens, object plane, and image plane for any desired magnification without visual focusing.

c, d. The test includes the information obtained in 202.202b, together with information on distortion. It is applied to photographic objectives that are to be used in precision copying cameras where the user wishes to be certain that the relative proportions of the image are not significantly different from those of the object. Since the distortion changes with magnification, it is advisable to specify a ratio for test that corresponds to the magnification most commonly used.

e. This is a general-purpose test to determine the suitability of a lens so far as its definition characteristics are concerned. It is performed photographically. In general, if a lens yields satisfactory results when subjected to this test, it is probable that no additional test for lateral chromatic aberration is necessary, and the lens will doubtless perform satisfactorily for either black-and-white or color photography.

f. This is the qualifying test for photographic objectives intended for use in airplane mapping projects. It is a photographic test and the determinations are made for the plane of best average definition.

g, h. The *f*-number may be obtained by dividing the equivalent focal length of the lens by the diameter of the effective aperture. These tests are primarily of value in determining the accuracy of the geometric *f*-number markings at maximum aperture and at additional specified apertures.

i, j. This test is applied to photographic objectives mounted in cameras. As the test is a photographic one requiring a time exposure, it is necessary that the stop be open when the lens is submitted for test. This is a useful test for nonprecision type airplane cameras where the collimation index markers are located in a detachable magazine.

k. This test is applied to the platen of a precision aerial mapping camera, which is the surface against which the film is pressed during exposure. It is a test to determine conformance to specifications requiring that the platen shall not depart from a true plane by more than ± 0.0005 in.

l. This test is applied to photographic objectives mounted in cameras. It gives the same information as test 202.202f except for back-focal distance. It is preferable that these lens characteristics be determined for the lens as mounted in a barrel shutter, but occasionally it is desirable to determine these quantities for the lens mounted in a camera. The shutter of the lens should be open when the camera is submitted for test.

m. This test is applied to a lens-camera combination that is to be used in photogrammetric mapping. It gives the departure of the principal point from the center of collimation which is the intersection point of lines joining opposite pairs of collimation index markers. Since it is necessary to determine the shift of the principal point resulting from the prism effect in the lens, the equivalent focal length of the lens as mounted in the camera is incidentally determined in this test, which checks whether the lens has been properly mounted to yield best average definition throughout the image field.

This test cannot be performed on a camera having a detachable magazine which bears the collimation index markers. This is the preliminary test on a precision type camera to determine compliance with specifications. If no provision has been made for ready adjustment of the collimation index markers and the 90° condition is not satisfied, the camera is returned to the firm or agency submitting the camera with recommendations regarding the necessary adjustments. If the 90° condition is satisfied, but no provision has been made for

ready adjustment of the principal point with respect to the center of collimation, the camera is returned with recommendations regarding the necessary adjustments.

n. If no provision has been made for ready adjustment of the lens in a transverse direction to properly position the principal point with respect to the center of collimation, or if this can be done by ready movement of the collimation index markers, this task is done in the course of the test. Following adjustment, the camera is checked and, if satisfactory, pins are set to insure preservation of the space relations between collimation index markers and principal point.

When a camera is submitted for test, it is mandatory that the drill holes for the pins be already present in one of the members that move with respect to one another. In addition, a proper sized drill and reamer and a sufficient number of pins to perform the doweling must accompany the camera. It is desired that roll pins be submitted for this task.

Item	Description	Fee
202.202a	Determination of focal length and back focal distance	$26.00
202.202b	Determination of equivalent focal length, back focal distance, separation of nodal points, and thickness	38.00
202.202c	Determination of equivalent focal length, back focal distance, separation of nodal points, and distortion at 5° intervals from the center to edge of field for one specified ratio of object to image size	105.00
202.202d	Fee for each additional ratio	55.00
202.202e	Determination of resolving power at 5° intervals from center to edge of field for parallel light at one aperture	30.00
202.202f	Determination of back focal distance, equivalent focal length, distortion and resolving power at 5° intervals from the center to edge of the field This is the test usually required for lenses that are to be mounted in precision airplane cameras.	69.00
202.202g	Determination of equivalent focal length and true geometric *f*-number for one marked stop	35.00
202.202h	Fee for each additional stop	10.00
202.202i	Determination of focal length for lens mounted in camera	43.00
202.202j	Fee for each extra magazine	25.00
202.202k	Determination of compliance of camera platen with flatness requirements to ±0.0005 in	15.00
202.202l	Determination of equivalent focal length, distortion, and resolving power at 7.5° intervals from center to edge of field for lens mounted in camera	82.00
202.202m	Location of the principal point, and check of 90° condition for lens mounted in camera	95.00
202.202n	Setting the principal point and 90° condition, checking and doweling for lens mounted in camera	72.00
202.202z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.203 Optical components, spectacle lenses, goggle lenses, etc.

Item	Description	Fee
	Optical components	
202.203a	Determination of equivalent focal length of single-component lens	$26.00
202.203b	Determination of a single radius of curvature (single surface or matched pair). Fee determined by the nature of the work required; minimum fee	56.00
202.203c	Determination of spherical and cylindrical power, axis of sphere, and axis of cylinder for a single spectacle lens	16.00
202.203d	Fee for each additional lens	10.00
202.203e	Determination of spherical and cylindrical powers, axis of sphere, and axis of cylinder for a single spectacle lens with bifocal segment	23.00
202.203f	Fee for each additional lens	15.00
	Sunglass lenses	
202.203g	Determination of refractive power, surface quality, and definition to determine compliance of a single sunglass lens with commercial standards	16.00
202.203h	Fee for each additional lens	10.00
	Goggle lenses	
202.203i	Determination of lens dimensions, refractive power, prismatic power, and definition; and making drop test on a single hardened goggle lens to determine compliance with Federal Specification GGG–G–501b	16.00
202.203j	Fee for each additional lens	10.00
202.203z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.204 Refractometric instruments. Every instrument submitted for test should be in good working order. The test slab or standard supplied by the maker, and the tables if any, must accompany each refractometer. Upon request special attention will be given to such portions of the scale as may be of particular importance in the contemplated use of the instrument. Refractometers with compensators will be tested with "white" light unless otherwise specified. Refractometers without compensators will be tested only with sodium light unless otherwise specified.

Item	Description	Fee
202.204z	For special tests and calibrations of refractometric measurements, fees will be charged dependent upon the nature of the test.	

202.205 Refractive indices. When submitting media for index measurement, the temperature, wavelength of light (or spectral line), and approximate degree of desired precision should be specified. Liquid samples should usually be as large as 10 ml. Solids for item d must be in the form of test slabs, approximately $1 \times \frac{1}{2} \times \frac{3}{16}$ in., such as are commonly used for the adjustment of Abbe refractometers. Two surfaces must be pitch polished (plane within approximately one wavelength) and intersect at 90° to form an unbeveled edge.

Item	Description	Fee
	Index of refraction ($\pm 1 \times 10^{-4}$) for *D* spectrum line for one liquid by precision Abbe refractometer:	
202.205a	Determination of index for single temperature	$29.00
202.205b	Determination of index for each additional sample submitted at the same time for same temperature, or for each determination and additional spectral lines for same temperature	11.00
202.205c	One index determination at each additional temperature	16.00
	Index of refraction ($\pm 1 \times 10^{-4}$) for *D* spectrum line for one solid by precision Abbe refractometer:	
202.205d	Determination of index for one sample	16.00
202.205e	Determination of index for each additional spectrum line, *C*, *F*, or *G*	6.50
	Determination of index of refraction ($\pm 1 \times 10^{-5}$) of solid submitted in form of 60° prism for one visible spectrum line:	
202.205f	Determination of index	26.00
202.205g	For each additional line in the visible spectrum	12.00
202.205z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.206 Polarimetric instruments.

Item	Description	Fee
202.206z	Calibration of polarimeters, saccharimeters, and quartz control plates. Fees determined by the nature and difficulty of the test.	

Photographic Research

202.311 Photography. The following information is pertinent to the tests a to f in this schedule.

a. American Standard Printing Transmission Density (Type P2–b) is measured on step tablets of 21 steps or less, with a densitometer calibrated to ± 0.01 density or ± 1 percent of the density, whichever is the greater. This type of density is the one most commonly employed in the photographic industry and is customarily implied when the type of density is not specified.

b. American Standard Diffuse Visual Transmission Density (Type VI–b) is measured on step tablets of 21 steps or less, witn a densitometer calibrated to ± 0.01 density or ± 1 percent of the density, whichever is the greater.

c, d. The determination of the residual sodium thiosulfate content of processed photographic film is made according to American Standard Method PH4.8–1958 or the latest revision thereof.

Hypo concentrations less than 0.005 mg per square inch are reported as "nil." When hypo concentration is 0.005 mg per square inch or over, it is reported to one significant figure.

Each sample submitted should be properly identified, contain no image (slight fog permissible), and must be submitted immediately after processing.

Each sample submitted should be 6 to 8 in. in length and should be attached securely to request letter by stapling.

Samples are not returned since they are destroyed during the test.

e, f. The determination of residual sodium thiosulfate concentration of processed photographic paper is made according to American Standard Method PH4.30–1962 or the latest revision thereof.

Each sample submitted should be properly identified, contain no image (slight fog permissible), and be of such dimensions that two strips, 1×4 in., can be cut for test.

Item	Description	Fee
202.311a	Calibration of photographic step tablets for printing density, one sample	$28.00
202.311b	Calibration of photographic step tablets for visual density, one sample	28.00
202.311c	Residual sodium thiosulfate concentration of processed film, one sample	12.00
202.311d	Each additional sample for the determination of residual sodium thiosulfate in film submitted at the same time	3.00
202.311e	Residual sodium thiosulfate concentration of processed photographic paper, one sample	20.00
202.311f	Each additional sample for the determination of residual thiosulfate concentration of processed photographic paper submitted at the same time	5.00
202.311z	For special tests not covered by the above schedule, such as precise determination of contact printing density and measurements of resolving power of photographic materials, fees will be charged dependent upon the nature of the test.	

Length

202.401 Reference line standards of length.

Item	Description	Fee
202.401z	Calibrations of reference line standards to a higher precision than that provided in schedule 202.402 are regarded as special tests. Fees will be charged dependent upon the nature of the test; they may be approximately estimated as twice the corresponding fees of schedule 202.402.	

202.402 Working line standards of length.

Item	Description	Fee
202.402a	Yard or meter working line standard—determination of the total length at room temperature to an accuracy of 0.001 mm if the character of the graduation justifies	$125.00
202.402b	Yard or meter working line standard—determination of the total length at an additional lower temperature to obtain the coefficient of expansion	110.00
202.402c	Yard or meter working line standard—determination of equal submultiples of a length, each	20.00
202.402d	Yard or meter working line standard—determination of any other single interval	65.00
202.402z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.403 Commercial line standards of length.

Item	Description	Fee
202.403z	Calibrations of commercial line standards of length to an accuracy of 0.01 mm or 0.0004 in., if the character of the graduation justifies, are regarded as special tests. Fees will be charged dependent upon the nature of the test; they may be approximately estimated as one-half of the corresponding fees of schedule 202.402.	

202.404 Steel tapes.

(a) Steel tapes accepted by the Bureau as suitable for calibration will be issued a National Bureau of Standards Report of Calibration. Steel tapes are used for many types of long-

interval length measurements. The varied requirements for the application of calibrated steel tapes to length measurements necessarily require variance in type and location of interval markings and accessory attachments. Some tapes, although being of excellent quality and having application that justifies NBS calibration, are not necessarily suitable for use as reference tapes (see paragraph b). Such steel tapes for which a Report of Calibration has been issued will be engraved with an NBS serial number for identification puposes. A steel tape considered by the Bureau to be suitable for use as a reference tape for checking other calibrated or uncalibrated steel tapes, or for other appropriate uses, will also be engraved with a mark indicating the year of calibration. Reports of Calibration normally will indicate the measured lengths of intervals to the nearest 0.001 foot or 0.1 mm. Length values will be reported at 68 °F (20 °C).

(b) A steel tape considered suitable for use as a reference tape, as defined above, should possess the following minimum requirements: The error in total length of the tape at the standard temperature of 68 °F (20 °C) and at standard tension shall not exceed 0.1 in. per 100 ft (2 mm per 25 m). The standard tension is 10 lb (4.5 kg) for tapes 25 to 100 ft, or from 10 to 30 m in length and 20 lb (9 kg) for tapes longer than 100 ft or 30 m. From the standpoint of inherent stability and to prevent the possibility of accidental displacement of reference graduations, a reference tape should normally possess the following characteristic: All interval graduations should be on a single piece of metal ribbon. This is usually construed to imply that the graduations should not be on pieces of solder, sleeves, thin plates or blocks bonded or attached to the tape, or on wire loops, spring balances, tension handles, or other accessories likely to be detached or changed in shape.

Item	Description	Fee
202.404a	Steel tape—determination of correction to the total length of the tape when supported throughout at standard tension and at standard temperature, for a tape not exceeding 200 ft or 50 m in length	$21.00
	This is the regular standard test which will be made and charged for in each case. To this amount must be added the fees for any additional tests made, and for item (n), if applicable, in accordance with the following schedule.	
202.404b	Steel tape—determination of the correction to the total length when supported throughout at any tension other than standard tension, for a tape not exceeding 200 ft or 50 m in length	4.00
	Tension desired must be specified.	
202.404c	Steel tape—determination of the correction to the total length when supported at the ends only	4.00
	The Bureau is not prepared to make this test on tapes having a greater length than 200 ft or 50 m. Standard tension will be used in this test unless another tension is specified.	
202.404d	Steel tape—determination of the correction to the total length when supported at the ends and one or more intermediate points, for a tape not exceeding 200 ft or 50 m in length	4.00
	Standard tension will be used unless another tension is specified.	
202.404e	Steel tape—determination of the correction to the length of a subinterval under the same conditions as to tension and points of support as for the total length	3.00
	The points at which these measurements are made must be points at which the tape is supported. The Bureau is not prepared to test tapes supported at points more than 200 ft or 50 m apart.	

Item	Description	Fee
202.404f	Steel tape—determination of the correction to the length of a subinterval under different specified conditions as to tension and points of support from those used for the total length See item (e) above.	$5.00
202.404g	Steel tape—determination of the tension to the nearest integral half-pound or quarter kilogram at which the correction to the length of an interval is most nearly zero, under a specified condition of support, for a tape not exceeding 200 ft or 50 m	5.00
202.404h	Steel tape—determination of the correction to a subinterval at the tension at which the correction to the total length is most nearly zero and under the conditions of support used in the test under item (g)	3.00
202.404i	Steel tape—determination of correction to the total length of an interval on the reverse side of the tape, when supported at standard tension and at standard temperature, for a tape not exceeding 200 ft or 50 m in length	5.00
202.404j	Steel tape—determination of the coefficient of expansion of a tape, fee will be determined in each individual case.	
202.404k	Steel tape—determination of Young's modulus of elasticity, for a tape not exceeding 200 ft or 50 m in length Not recommended for tapes having enameled, plastic, or heavy varnish coatings.	15.00
202.404l	Steel tape—determination of the weight per foot or per meter of a tape	6.00
202.404m	Spring balance—testing in horizontal position	10.00
202.404n	Steel tape—additional charge for each tape sent without reel	4.00
202.404o	Steel tape—determination of AE	10.00
202.404p	Steel tape—computed values (this does not include charge for necessary measurements)	5.00
202.404z	For special tests not covered in the above schedule, fees will be charged dependent upon the nature of the test.	

202.405 Invar base-line tapes. For testing of steel tapes, see schedule 202.404. The test of an Invar base-line tape of any length less than 50 m on the NBS geodetic-tape comparator will, in general, be made for the same fee as a 50-m Invar base-line tape. Attention is called to the fact that only Invar base-line tapes of certain lengths can be tested on this comparator. Invar tapes not tested on the geodetic-tape comparator will be tested on the bench standard under items 202.405 (l) and (m).

Item	Description	Fee
202.405a	Invar 50-m base-line tape—determination on the geodetic comparator of total length with a probable error not greater than ±0.050 mm	$130.00
202.405b	Invar 50-m base-line tape—determination on the geodetic comparator of total length at an additional tension and/or method of support, with a probable error not greater than ±0.050 mm	40.00
202.405c	Invar 50-m base-line tape—determination of total length supported throughout, by computation from the observed length when supported at the ends and one or more intermediate points	20.00
202.405d	Invar 50-m base-line tape—high-precision calibration of a group of uniformly spaced subintervals when supported on a horizontal flat surface, using the same tension specified for test item 202.405c. Charge for each interval	20.00
202.405e	Invar 50-m base-line tape—determination on the geodetic comparator of the coefficient of expansion with an accuracy of at least 0.000001 per degree Celsius using the electrical resistance method and calibration of its total length at one temperature, tension, and method of support with a probable error not greater than ±0.050 mm	225.00
202.405f	Invar base-line tape—determination of Young's modulus of elasticity	15.00
202.405g	Invar base-line tape—determination of the weight per meter (or per foot)	6.00
202.405h	Spring balance—testing in horizontal position	10.00
202.405i	Invar base-line tape—additional charge for each tape sent without a reel	4.00
202.405j	Invar base-line tape—determination of AE	10.00
202.405k	Invar base-line tape—computed values other than as provided in item 202.405c	5.00
202.405l	Invar base-line tape not more than 50 m in nominal length—determination on bench standard at room temperature of length of one interval when supported at one method of support and under one tension, or determination of the tension to the nearest integral half pound or quarter kilogram at which the correction to the length of the interval is most nearly zero at a specified method of support	33.00
202.405m	Invar base-line tape not more than 50 m in nominal length—each additional determination on bench standard at room temperature of length of interval, or tension to the nearest integral half pound or quarter kilogram at which the correction to the length of an interval is most nearly zero	13.00
202.405z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.406 Surveyors' measuring instruments (other than tapes).

Item	Description	Fee
202.406a	Leveling rod—testing principal intervals	$48.00
202.406z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.407 Sieves.

NOTE: The precision seal of the National Bureau of Standards on any sieve indicates that the sieve has been tested at the Bureau and found to conform to specification. Except by special arrangements, the testing of sieves at the Bureau is limited to No. 2½ to No. 400 inclusive.

Item	Description	Fee
202.407a	Sieve—test of a sieve No. 2½ to No. 400 inclusive to determine conformity to specification, but not including the sieving test	$16.00
202.407z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.408 Haemacytometers. Each haemacytometer chamber and each cover glass which passes the specification is marked with a National Bureau of Standards precision seal. In general, work will be discontinued when a substantial number of items in a lot fail to comply with the specifications, and the fee will be computed on the basis of the number of items tested plus a special handling charge. Items 202.408a to e inclusive will be applicable if a minimum of 12 chambers are submitted at one time; otherwise item 202.408z will be applicable. Only one letter reporting results of test will be supplied for any one test at the prices of items 202.408a to e inclusive.

Item	Description	Fee
202.408a	Single Neubauer haemacytometer chamber—testing single cell chamber (having Neubauer ruling) and two cover glasses for conformity with specification	$7.00
202.408b	Single Fuchs-Rosenthal haemacytometer chamber—testing single cell chamber (having Fuchs-Rosenthal ruling) and two cover glasses for conformity with specification	10.00
202.408c	Double Neubauer haemacytometer chamber—testing double cell chamber (having two Neubauer rulings) and two cover glasses for conformity with specification	8.00

Item	Description	Fee
202.408d	Double Fuchs-Rosenthal haemacytometer chamber—testing double cell chamber (having two Fuchs-Rosenthal rulings) and two cover glasses for conformity with specification	$20.00
202.408e	Quadruple haemacytometer chamber—testing quadruple cell chamber (having two Neubauer rulings and two Fuchs-Rosenthal rulings) and two cover glasses for conformity with specification	21.00
202.408z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.409 Areas and area-measuring instruments.

Item	Description	Fee
202.409z	Special tests only are conducted in this category and fees will be charged dependent upon the nature of the test.	

202.410 Precision circles.

Item	Description	Fee
202.410z	Special tests only are conducted in this category and fees will be charged dependent upon the nature of the test.	

202.411 Linear thermal expansion of solids.

Item	Description	Fee
202.411z	Special tests only are conducted in this category and fees for accepted tests will be charged dependent upon their nature. Only those tests that cannot be carried out elsewhere may be accepted.	

202.412 Gage blocks.

(a) Test fee schedules in 202.412 include a statement of the accuracy to which measurements are ordinarily made; however, if the character of the defining surfaces of a gage block is not such as to warrant this accuracy, the report will show the accuracy actually obtained. All gage blocks submitted for test should be in substantially new block condition and each block should be marked with an identification number.

(b) In the shipment of gage blocks extreme precaution should be taken both against corrosion and damage by contact with other gage blocks during transit. All defining steel surfaces should be greased and the blocks padded with waxed paper or volatile rust inhibitor

treated paper. A greased steel surface coming in contact with newspaper, wrapping paper (unwaxed) or excelsior is very likely to corrode. Sets of gage blocks should have packing inside the case, and the case should be bound shut as the clasps frequently open or break during shipment.

(c) Shipments and purchase orders should be sent to the National Bureau of Standards, Washington, D.C. 20234, marked to the attention of the Length Section.

Item	Description	Fee
202.412a	Gage blocks—determination of length to ±0.000004 in. and excessive errors in flatness and parallelism, for sizes from 0.100 in. to and including 1.000 in., in lots of 10 or more, each	$7.00
	Actual cost of calibration will be charged for smaller lots.	
202.412b	Gage blocks—determination of length to ±0.000005, ±0.000006, and ±0.000007 in., respectively, for blocks from 1 to 2 in., 2 to 3 in., and 3 to 4 in. in length, and excessive errors in flatness and parallelism, in lots of three or more, each	21.00
	Actual cost of calibration will be charged for smaller lots.	
202.412ab	Measurements as described under items (a) and (b) for usual 81-block set, per set	525.00
	Extra blocks will be charged for under items (a) or (e).	
202.412c	Gage blocks—determination of length to ±0.000002 in. and excessive errors in flatness and parallelism, for sizes from 0.100 in. to and including 1.000 in., in lots of 10 or more, each	11.00
	Actual cost of calibration will be charged for smaller lots.	
202.412d	Gage blocks—determination of length to ±0.000002, ±0.000003, and ±0.000004 in. respectively, for blocks from 1 to 2 in., 2 to 3 in., and 3 to 4 in. in length, and excessive errors in flatness and parallelism, in lots of three or more, each	32.00
	Actual cost of calibration will be charged for smaller lots.	
202.412cd	Measurements as described under items (c) and (d) for usual 81-block set, per set	880.00
	Extra blocks will be charged for under items (c) or (e).	
202.412e	Gage blocks—determination of length to ±0.000003 in. and excessive errors in flatness and parallelism, for sizes from 0.010 to and including 0.090 in., in lots of 10 or more, each	8.00
	Blocks in this size range are usually warped and do not warrant calibration to a higher accuracy. In special cases blocks 0.040 in. and thicker will be calibrated under item (c) if the errors in flatness of the blocks are not excessive.	
202.412f	Gage blocks—determination of length to ±0.000001 in. per inch of length and excessive errors in flatness and parallelism, for blocks of the following length: 5, 6, 7, 8, 10, 12, 16, and 20 in., in lots of three or more, each	50.00
	Actual cost of calibration will be charged for smaller lots.	

Item	Description	Fee
202.412z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

Engineering Metrology

202.500 General.

(a) Test fee schedules 202.501 to 202.509 include a statement of the relative accuracy to which measurements are ordinarily made. However, if the character of the defining surface of a gage or other article is not such as to warrant the measurement to this accuracy, the report will show the accuracy actually obtained. If a greater accuracy is requested and the defining surfaces are such as to permit measurements to the accuracy requested, the necessary measurements will be made and a special fee will be charged.

(b) In addition to the items covered by schedules 202.501 to 202.509 other items such as gage block accessories, taper plug and ring gages, and gill net gages are occasionally calibrated. Other sizes than those listed in the fee schedules are also calibrated on special request. These tests and calibrations are made so infrequently that it is not practical to list a definite fee, and such work will be done on the basis of the cost of the work.

(c) In the shipment of gages, extreme precautions should be taken both against corrosion and damage by contact with other gages during transit. All defining steel surfaces should be greased and protected with waxed paper or a suitable strippable plastic coating. A greased steel surface coming in contact with newspaper, wrapping paper (unwaxed), or excelsior is very likely to corrode. Small gages suitably wrapped may be fastened in place in a strong rigid container so that no movement is possible. Plug and ring gages should ordinarily not be shipped mated. In the case of large-size threaded plugs and rings, however, mating is permissible as a means of protecting the plug threads. In such cases a grease must be used that will prevent electrolytic corrosion between the mating gages.

(d) Minimum test fee for calibration work is $20.00.

202.501 End standards of length.

Item	Description	Fee
	End standards with spherical or pointed ends, or flat ends with area of contact less than ⅓ in.²:	
202.501a	Determination of length to ±0.00005 in. for lengths up to and including 8 in., each	$12.00
202.501b	Determination of length to ±0.000005 in. per inch of length for lengths over 8 in. up to and including 20 in., each	16.00
202.501c	Determination of length to ±0.000005 in. per inch of length for lengths over 20 in. up to and including 40 in., each	20.00
202.510d	Determination of length to ±0.000005 in. per inch of length for lengths over 40 in. up to and including 72 in., each	24.00
202.501e	Determination of length to ±0.00002 in. for lengths up to and including 8 in., each	24.00

Item	Description	Fee
202.501f	Determination of length to ±0.000003 in. per inch of length for lengths over 8 in. up to and including 20 in., each	$32.00
202.501g	Determination of length to ±0.000003 in. per inch of length for lengths over 20 in. up to and including 40 in., each	40.00
202.501h	Determination of length to ±0.000003 in. per inch of length for lengths over 40 in. up to and including 72 in., each	48.00
202.502z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.502 Plain cylindrical plug and ring gages.

Item	Description	Fee
202.502a	Plain cylindrical plug gages—determination of diameter, taper, and roundness to ±0.00005 in. for sizes up to and including 4 in., each	$12.00
202.502b	Plain cylindrical plug gages—determination of diameter, taper, and roundness to ±0.00001 in. for sizes up to and including 2 in., each	35.00
202.502c	Plain cylindrical plug gages—determination of diameter, taper, and roundness to ±0.000005 in. for sizes up to and including 2 in., each	50.00
202.502d	Plain cylindrical ring gages—determination of diameter, taper, and roundness to ±0.00001 in. for sizes 0.03 in. up to and including 2 in., each	50.00
202.502e	Plain cylindrical ring gages—determination of diameter, taper, and roundness to ±0.000005 in. for sizes 0.03 in. up to and including 2 in., each	75.00
202.502f	Plain cylindrical ring gages—determination of diameter, taper, and roundness to ±0.000003 in. for sizes 0.25 in. up to and including 2 in., each	100.00
202.502z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.503 Thread plug and ring gages.

Item	Description	Fee
202.503a	Straight thread plug gages and setting thread plug gages—determination of angle to 3′ to 15′ depending on pitch and diameter; lead error and pitch diameter to 0.0001 in., major diameter to 0.0002 in. thread form as to clearance, for sizes ¼ in. to 6 in., each	$30.00

Item	Description	Fee
202.503b	Straight thread ring gages—determination of angle to 3′ to 15′ depending on pitch and diameter, lead error to 0.0001 in., minor diameter to 0.0002 in., thread form as to clearance, and fit on setting plug, for sizes ¼ in. to 6 in., each	$30.00
202.503c	Taper thread plug gages having 60° threads (except API Cable and Rotary gages)—determination of half angles to 3′ to 15′ depending on pitch and diameter, lead error, pitch diameter and taper to 0.0001 in., major diameter to 0.0003 in., and thread form as to clearance, for sizes up to and including 10 in., each	75.00
202.503d	Taper thread plug gages having 60° threads—determination of half angles to 3′ to 15′ depending on pitch and diameter, lead error and taper to 0.0001 in., pitch diameter to 0.0002 in., major diameter to 0.0004 in., and thread form as to clearance, for sizes over 10 in. to 24 in., inclusive, each	95.00
202.503e	Taper thread ring gages having 60° threads (except API Cable and Rotary gages)—determination of angle to 3′ to 15′ depending on pitch and diameter, lead error to 0.0001 in., taper to 0.0002 in., minor diameter to 0.0005 in. (or truncation of thread crest), thread form as to clearance, and standoff from mating plug to 0.002 in. for sizes up to 10 in., each	60.00
202.503f	Taper thread ring gages having 60° threads—determination of angle to 3′ to 15′ depending on pitch and diameter, lead error to 0.0001 in., taper to 0.0002 in., minor diameter to 0.0005 in. (or truncation of thread crest), thread form as to clearance, and standoff from mating plug to 0.002 in., for sizes over 10 in. to 24 in. inclusive, each	95.00
202.503g	API Cable and Rotary taper thread plug gages—determination of dimensions specified in API Standard 7, each	110.00
202.503h	API Cable and Rotary taper thread ring gages—determination of dimensions specified in API Standard 7, each	75.00
202.503i	API Cable and Rotary tool connection gages—determination of mating standoff and standoff from grand master gages, per set	30.00
202.503j	API sucker rod plug gages designated as P1, P5, P7, B2, and B6—determination of dimensions specified in API Standard 11B, each	30.00
202.503k	API sucker rod plug gages designated as P3 and B4—determination of dimensions specified in API Standard 11B, each	60.00
202.503l	API sucker rod ring gages designated as P2, P6, P8, B1, and B5—determination of dimensions specified in API Standard 11B, each	30.00
202.503m	API sucker rod ring gages designated as P4 and B3—determination of dimensions specified in API Standard 11B, each	50.00

Item	Description	Fee
202.503n	API sucker rod gages—determination of dimensions specified in API Standard 11B for the inspection of used gages, per set of any size	$140.00
202.503o	API buttress casing plug gages—determination of dimensions specified in API Standard 5B for sizes up to 10 in., each	85.00
202.503p	API buttress casing plug gages—determination of dimensions specified in API Standard 5B, for sizes over 10 in., each	105.00
202.503q	API buttress casing ring gages—determination of dimensions specified in API Standard 5B, for sizes up to 10 in., each	70.00
202.503r	API buttress casing ring gages—determination of dimensions specified in API Standard 5B, for sizes over 10 in., each	95.00
202.503z	For special tests not covered by the above schedule fees will be charged dependent upon the nature of the test.	

202.504 Instruments and components.

Item	Description	Fee
202.504a	Micrometer calipers—determination of errors at 10 points selected to test uniformity of graduations as well as lead errors. Also determination of planeness and parallelism errors of contact surfaces, each	$50.00
202.504b	Dial micrometers—determination of errors in each one-tenth revolution of the pointer for one revolution and each half revolution up to five revolutions, each	35.00
	In the case of dial micrometers, the accuracy obtainable depends on the value of the smallest division on the dial and on the mechanical condition of the instrument as evidenced by the degree to which it will repeat its indications.	
202.504c	Thread wires—determination of diameter, straightness, and roundness of each of three wires in a set in accordance with specification for wires in NBS Handbook H28, Screw Thread Standards for Federal Services, and determination of mean diameter and C correction, for the best sizes of wires for standard 60° screw threads, from 2 to 80 threads per inch and for 29° Acme screw threads from 1 to 20 threads per inch, per set of three wires	6.00
202.504d	Gear wires—determination of diameter, straightness, and roundness of each of two wires in a set to an accuracy of ±0.000010 in., per set	6.00
202.504e	Master wires—determination of mean diameter, and straightness to an accuracy of ±0.000005 in., each	15.00

Item	Description	Fee
202.504f	Penetration needles—test for compliance with ASTM specification D5–52 without reporting actual dimensions, each	$3.00
202.504g	Penetration needles—test for compliance with ASTM specification D5–61 with dimensions reported, each	25.00
	Request quotation on test of six or more needles on above test.	
202.504h	Petroleum wax penetration needles—test for compliance with ASTM Specification D1321–61T, without reporting dimensions, each	5.00
	Penetration needles must be serial numbered; otherwise, needles will be numbered by the Bureau, each	12.00
202.504i	Polariscope tubes—determination of the average length of polariscope observation tube and marking with NBS serial number if length is within ±0.03 mm of nominal length for 100 and 200 mm tubes and ±0.04 mm for 400 mm tubes, each	24.00
202.504z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.505 Optical reference planes.

Item	Description	Fee
	Optical reference planes are tested interferometrically, horizontally supported with test surface supported on three equally spaced pads located at 0.7 of the radius from the center. The test is performed along two marked diameters at 90° to each other on each surface, when each diameter is parallel to two of the support pads. Graphs of the profiles are supplied.	
202.505a	Optical reference plane—to an accuracy of ±0.0000005 in. for sizes not exceeding 6 in., per surface	$70.00
202.505b	Optical reference plane—to an accuracy of ±.0000005 in. for sizes larger than 6 in. but not exceeding 8 in. in diameter, per surface	100.00
202.505c	Optical reference plane—to an accuracy of ±0.0000005 in. for sizes larger than 8 in. but not exceeding 10 in. in diameter, per surface	150.00
202.505d	Optical true plane not exceeding 3 in. in diameter—measured along four marked diameters at 45° to each other, to an accuracy of ±0.0000002 in. Test performed by intercomparison of a group of three similar planes supplied by customer. Total of 12 diameters—four each on one surface of three planes	500.00
202.505z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.506 Angle blocks.

Item	Description	Fee
202.506a	Calibration of set of AA grade angle blocks consisting of one each of the following sizes: 1, 3, 5, 20, and 30″; 1, 3, 5, 20, and 30′; 1, 3, 5, 15, 30, and 45°;—determination of flatness of faces, parallelism of elements of surfaces and angle between faces. Accuracy of angle between faces 0.5″. Per set	$350.00
202.506z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.507 Polygons.

Item	Description	Fee
	Calibration of polygons—determination of flatness of faces, variation of the angles between faces and the base of the polygon (where possible the polygon will be adjusted for minimum variation) and the angle between faces. Accuracy of values for angles between faces 0.5″ or less.	
202.507a	Polygons having 4 or 5 sides, each	$175.00
202.507b	Polygons having 8, 9, or 10 sides, each	200.00
202.507c	Polygons having 12 sides, each	250.00
202.507d	Polygons having 24 sides, each	400.00
202.507e	Polygons having 36 sides, each	800.00
202.507f	Polygons having 72 sides, each	2,000.00
202.507z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.508 Master balls.

Item	Description	Fee
202.508a	Steel or Carbide balls—determination of diameter to ±0.000050 in. for sizes from 1/16 in. to 1 in., each	$10.00
202.508b	Steel or Carbide balls—determination of diameter to ±0.000010 in. for sizes from 1/16 in. to 1 in., each	15.00

Item	Description	Fee
202.508c	Master ball—determination of diameter to ±0.000005 in. by comparison with NBS master and measurement of roundness of two equators, for sizes from ⅛ in. to ½ in. by 1/32 in. steps and ½ in. to 1 in. by 1/16 in. steps. Test applied only on balls with diameter variation of 0.000005 in. or less and deviation from nominal size within ±0.000030 in., each	$25.00
202.508d	Master balls—determination of mean diameter from five interferometric readings to an accuracy of ±0.000003 in. and measurement of roundness of four equators. For sizes up to 1 in. in diameter. Test made only on balls with diameter variation of 0.000003 in. or less, each	60.00
202.508z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

202.509 Gears.

Item	Description	Fee
202.509a	Tooth index measurement—calibration results recorded in tape form with each tooth location being represented by a plateau and another tape (taken simultaneously) of the reference diameter location during the tooth index calibration. Gears, master gears, gear cutters, and index plates, from 0.125 in. diam to about 8.0 in. diam and from about 24 teeth to about 500 teeth. The maximum overall length of the part must be less than 3 in. Suitable reference and calibration surfaces must be available to obtain the estimated accuracy of ±3″ of arc. For 71 teeth or less, each	$160.00
	For 72 teeth or more, each	200.00
	The cost of any needed adaptors will be added to the calibration cost, if made by the Bureau.	
202.509z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

Mass and Volume

202.610 General.

(a) Calibration and testing.

(1) Calibration consists of determining the value, either mass or volume, relative to an accepted standard. It is assumed that all items submitted for calibration will be used as reference standards. (This designation implies the use of a correction or actual value of the standard in all measurements relative to it.) Results of a calibration will be reported in a National Bureau of Standards Report of Calibration listing the value together with an appropriate uncertainty. The Report of Calibration makes no reference to the compliance with existing class tolerances which limit the departure of actual value from the nominal value.

(2) Testing consists of establishing compliance with applicable specifications or tolerances. If the need is critical and the service is not available elsewhere, items may be accepted

for test. The results of the test will be reported in a National Bureau of Standards Report of Test, which generally is a statement indicating the compliance, or noncompliance, with the particular specification or tolerance.

(3) Acceptance for calibration or test is based on inspection at the Bureau. Acceptance is based on suitability for use as a reference standard. Items not accepted for calibration or test will be returned, the appropriate cleaning, handling, and inspection fee being applicable.

(4) The established fees are based on satisfactory test or calibration effected by normal procedures. Total cost of test or calibration will include cost of items required to facilitate the use of normal procedures. Examples of items, the cost of which will be added to the established fees as routine procedure, are replacement of missing small weights, repairs to damaged surfaces, the cleaning and greasing of glass stopcocks, repairs to shipping cases or crates, and the reconditioning or modification of closures for weight-adjustment cavities.

(5) Occasionally items are received for test which vary excessively from nominal. Such variation becomes evident in the actual calibration or test. Completion of calibration or test may require considerable deviation from normal procedures. For such cases, the fee will be computed on a cost basis.

(6) When requested, receipt of items and purchase orders will be acknowledged. Such acknowledgment will not contain a price quotation. Actual cost of the calibration or test will be stated in the acknowledgment copy of NBS Form 64. Usually, this acknowledgment is issued sufficiently in advance of the completion of the work so that change orders can be processed prior to return shipment.

(b) Correspondence and purchase orders.

(1) All correspondence concerning calibration and testing should be addressed to the National Bureau of Standards, Attention: Mass and Volume Section, 2.06, Washington, D.C., 20234.

(2) The purchase order or calibration request must include complete information concerning the following items:

(i) Purchase order number or authority to charge against existing open purchase order.

(ii) Legal owner of item.

(iii) Nominal designation and total number of items by count.

(iv) Shipping instructions for shipment to other than name stated in (i).

(v) Previous Bureau of Standards test number if appropriate.

(3) After completion of calibration or test, items will be packed and shipped as directed. The Report of Calibration or the Report of Test, whichever is applicable, will be mailed under separate cover.

202.611 Reference standards of mass.

(a) Reference standards of mass are weights or weight sets of design, material, and surface finish comparable to, but not necessarily limited to present Class A, B, M, S, or S–1 as described in Circulars 3[4] and 547[5] in Volume III of NBS Handbook 77. Standards accepted are calibrated with reference to NBS standards of mass, with an uncertainty compatible with the equipment and methods used.

(b) Packing and shipping.

(1) Weights must be carefully packed. If shipped in their regular cases the weights should be tightly packed in their pockets by the use of extra material of some sort.

(2) In many instances the sheet-metal weights that are packed under the glass covers of the regular cases reach the Bureau bent or otherwise damaged. Care should be given the

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[4] NBS Circular 3, Design and test of standards of mass. In NBS Handbook 77, Precision Measurement and Calibration, Vol. III, Optics, Metrology, and Radiation, p. 615 (see pp. 101–102 for price information and order form).

[5] NBS Circular 547, Precision laboratory standards of mass and laboratory weights. Price 35 cents. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Also in NBS Handbook 77, Precision Measurement and Calibration, Vol. III, Optics, Metrology, and Radiation, p. 588 (see pp. 101–102 for price information and order form).

packing of these weights. Sufficient extra packing should be used to hold the glass cover firmly in place.

(3) Many of the laboratory and storage weight cases now in service are not designed to retain the weights in the pockets during shipment. Also, shipments of weights are sometimes subjected to exceptionally rough handling. It is strongly recommended that weights larger than about 200 g be removed from the laboratory or storage cases and packed for shipment as described in this section. Do not ship empty storage cases.

(4) Some soft but firm material should be used next to the weight and bound tightly against it to avoid possibility of abrasion. If tissue paper is used, many thicknesses should be firmly wrapped on. This should then be covered with thicker, tougher material such as cotton gauze or knit goods. The whole should then be wrapped securely in heavy wrapping paper to exclude the dust and grit from rough packing material. Each package should be clearly labeled.

(5) Weight identification, purchase order number, and legal owner must be clearly designated on the packing slip. Enclose packing slip in envelope and attach to outside of box (wrap with weights if package is small). Envelope should be clearly marked. Also package with the weights an information sheet stating the density and composition or accepted trade name of the material of which the weights are made, also the construction and surface protection of the weights.

(c) Calibration.

(1) Cleaning, inspection, and handling in accordance with fee 202.611 (a through d) will apply to all weights accepted for calibration.

(2) The true mass and/or apparent mass corrections are determined using computed volumes based on the manufacturers statement of density of the material. (In the absence of this information, estimated densities are used.) The apparent mass correction at 20 °C is computed with reference to Normal Brass (density 8.4 g/cm^3 at 0 °C: Volume coefficient expansion 0.000054/C°, air density 1.2 mg/cm^3). Apparent mass corrections computed to any other basis will be furnished if requested. Fee in accordance with 202.611 (e through z) will apply for calibration.

(3) Measurement of volumes for use in computing corrections will be done on a cost basis (202.611z). Correspondence or consultation as to the exact requirements must provide a basis for such calibration.

Item	Description	Fee
	Inspection, cleaning, and handling (also applies to weights not accepted for calibration)	
202.611a	For single weight not greater than 50 lb or 20 kg	$12.00
202.611b	For each set or group of weights submitted as a unit, when the largest weight is not greater than 2 lb or 1 kg	17.00
202.611c	For each set or group of weights submitted as a unit, when the largest weight is not greater than 20 lb or 10 kg but is greater than 2 lb or 1 kg	25.00
202.611d	For each set or group of weights submitted as a unit when the largest weight is not greater than 50 lb but is greater than 20 lb or 10 kg	35.00
	Calibration, in addition to appropriate inspection, cleaning, and handling fees	

Item	Description	Fee
202.611e	For sets 100 g to 1 mg, or sets within this range	$140.00
202.611f	For sets 100 g to 50 mg, or sets within this range	120.00
202.611g	For sets 100 g to 1 g, or sets within this range	60.00
202.611h	For sets 1 g to 1 mg, or sets within this range	80.00
202.611i	For individual weights, 100 g or less	10.00
202.611j	For each individual weight greater than 100 g but not greater than 2 kg	15.00
202.611k	For each individual weight greater than 2 kg but not greater than 20 kg	20.00
202.611z	Other operations will be charged for on the basis of actual cost of time and materials.	

202.612 Large mass standards.

(a) Large mass reference standards are weights over 50 lb (up to and including 10,000 lb). Acceptance for calibration is based on suitability with regard to general design and upon assurance of usage as a reference standard.

(b) Weights over 50 lb will be accepted for testing or standardization provided the need is critical and the service is not available elsewhere. (Testing is to determine compliance or noncompliance with accepted specifications. Standardization includes testing and adjustment to comply with appropriate adjustment tolerance.)

(c) Packing and shipping:

(1) Arrangements for testing or calibration should be completed before weights are shipped to the Bureau. All correspondence must be addressed to the National Bureau of Standards, Mass and Volume Section, 2.06, Washington, D.C., 20234.

(2) Weights from 51 lb to approximately 250 lb must be clean, suitably protected, and shipped in wooden boxes having screw-fastened covers. Larger weights must be clean, suitably protected, and shipped in reusable crates. Adjustment cavity seals must be packed separately and included with all new weights shipped to the Bureau for standardization. The empty adjustment cavities must be suitably protected to exclude dirt and moisture while in transit.

(3) Ship weights as follows:

(i) Test weights of 50 lb and reference standards of 51 to 1,000 lb: From the West Coast and the Rocky Mountain area, ship to the National Bureau of Standards, Boulder, Colo., 80310; from the Midwest, ship to the National Bureau of Standards Master Scale Depot, 5800 West 69th Street, Chicago, Ill., 60600; from the East, ship to the National Bureau of Standards, Connecticut Avenue and Van Ness Street, N.W., Washington, D.C., 20234.

(ii) 1,001 to 10,000 lb: It is desirable that weights larger than 1,000 lb be submitted to the National Bureau of Standards Master Scale Depot, 5800 West 69th Street, Chicago, Ill., 60600; however, by previous correspondence, arrangements can be made for accepting such weights at the National Bureau of Standards in Washington, D.C.

(d) Adjusting material: When large amounts of adjusting material are required for new weights, the Bureau reserves the right to add the cost to the test fee or to require the owner or maker to furnish the material.

(e) Calibration, test, and standardization: For a calibration, the value of the weight or object (apparent mass with reference to Normal Brass) together with a statement of uncertainty

will be reported on an NBS Report of Calibration. Weights accepted for test will be reported as either complying or not complying with appropriate specifications on an NBS Report of Test. Weights accepted for standardization will be reported as complying with appropriate adjustment tolerance specifications on an NBS Report of Test. Fees in accordance with 202.612 (a thru z) apply.

Item	Description	Fee
	Test Weights, 50 lb, Class C, Cast Iron	
202.612a	A handling fee of $2.25 per weight in addition to the applicable test fee will be charged for each weight of a group submitted; the minimum handling charge shall be	$12.00
	The Bureau no longer tests weights of this kind on a routine basis. Special need or requirement for this work must be established.	
202.612b	Tolerance testing (no adjustment), per weight	8.00
202.612c	Standardization, per weight	16.00
	Test weights, 51 to 1,000 lb	
202.612d	Test and, when adjustable, standardize within Class C adjustment tolerances	25.00
202.612e	Calibration only (precision 1/100,000)	20.00
	Test weights, 1,001 to 2,500 lb	
202.612f	Test and, when adjustable, standardize to nominal value with precision of 0.01 lb	35.00
202.612g	Calibration only (precision 1/100,000)	30.00
	Test weights, 2,501 to 10,000 lb	
202.612h	Calibration only (precision 1/25,000)	35.00
202.612i	Calibration only (precision 1/100,000)	42.00
202.612j	Standardization, in addition to either 202.612h or 202.612i	25.00
	Cars, railway track scale test	
202.612k	Standardization on Master Track Scale at National Bureau of Standards Master Scale Depot, 5800 West 69th Street, Chicago, Ill.	40.00
	Test weights, 10,000 to 150,000 lb	
202.612z	Fees for tests of weights in this grouping will be charged dependent upon the nature of the test.	

202.613 Calibration of mass elements of pressure-gage testing apparatus.

Calibration consists of cleaning, marking with suitable designation when required, and determining the value, which for weights of one pound and greater is reported to a precision of 1 part in 100,000. The fee is in accordance with fee schedule item 202.613a.

Item	Description	Fee
212.613a	Each item to be calibrated	$6.00

202.614 Recalibration of mass standards. Recalibration of reference mass standards should be based on monitoring the difference between weights or groups of weights in the set. As long as the differences as measured agree with the computed differences, the set can be considered constant. Mass standards submitted for recalibration will be cleaned, inspected, and tested by intercomparison. If this intercomparison shows there has not been a sufficient change to warrant complete recalibration, a letter so stating and referring to the previous National Bureau of Standards Report of Calibration will be issued. Such a letter may include new values for one or two weights if necessary. Fee will not exceed that listed under 212.611, 202.612, or 202.613, whichever is applicable.

202.615 Glass volumetric apparatus.

(a) Glass volumetric apparatus is tested generally by weighing the amount of distilled water contained or delivered with reference to the graduations marked on the instrument. The quality of the markings and the care exercised in reading or setting the liquid level are major factors in both calibration and usage. Occasionally such instruments are used as reference or transfer standards which require calibration. Many usage requirements are satisfied by testing for compliance with existing capacity tolerance specifications. The Mass and Volume Section offers both calibration and testing, subject to certain restrictions.

(b) Instruments suitable for, and to be used for, reference or transfer standards will be accepted for calibration. Such instruments must essentially conform to the specifications contained in NBS Circular 602,[6] Testing of Glass Volumetric Apparatus. Acceptance for calibration is based on correspondence or consultation concerning the exact manner in which the instrument is to be used. If accepted for calibration, the instrument will be marked with an identification number, calibrated, and the results reported on an NBS Report of Calibration. The report will state the capacity under the conditions of test together with an associated statement concerning uncertainty. Fee for calibration will be computed on a cost basis.

(c) Precision grade glass volumetric apparatus will be accepted for testing to determine compliance with specifications and tolerances if the need is critical and the service is not available elsewhere. Acceptance for test is based on conformance with the specifications contained in NBS Circular 602,[6] or other appropriate specifications. The item will be marked with an appropriate stamp if test results indicate conformity with NBS-approved specifications and tolerances. No individual report will be issued (see paragraph d below for exception). Fee for testing is in accordance with 202.615 (a through l).

(d) A report will be furnished listing the test results for groups of blood pipets to be used as factory standards, if requested. Fees in accordance with 202.615p.

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[6] NBS Circular 602, Testing of glass volumetric apparatus. Price 20 cents. Available from Superintendent of Documents, U.S. Government, Printing Office, Washington, D.C., 20402. Also in NBS Handbook 77, Precision Measurement and Calibration, Vol. III, Optics, Metrology and Radiation, p. 723 (see pp. 101 and 103 for price information and order form).

Item	Description	Fee
	Testing in accordance with specifications in NBS Circular 602 [6] or other approved specifications.	
202.615a	Flasks of capacities up to and including 250 ml, each	$3.50
202.615b	Flasks of capacities exceeding 250 ml, each	4.50
202.615c	Flasks marked both "to contain" and "to deliver," each	6.50
202.615d	Flasks, of any capacity, when bearing more than one graduation mark. Primary capacity, each	4.00
202.615e	Each capacity in addition to primary (number determined by the Bureau)	1.75
202.615f	Flasks, specific gravity, each	8.50
202.615g	Cylindrical graduates, capacities up to and including 250 ml, each	10.00
202.615h	Cylindrical graduates, capacities exceeding 250 ml, each	12.00
202.615i	Transfer pipets, each	3.00
202.615j	Burets, except automatic, each	12.00
202.615k	Burets, automatic, each	14.00
202.615l	Measuring pipets, each	9.00
202.615m	Items a thru l disqualified for test on initial inspection, per item	3.00
202.615n	Dilution pipet, including Trenner automatic and Sahli, each	1.00
202.615o	Dilution pipets, automatic, other than Trenner, each	5.00
202.615p	Report of test for quality control purposes (applies to 202.615n and o only), each item	1.00
202.615q	Apparatus n and o disqualified for test on initial inspection, each	1.00
202.615r	Items except those above for which there are accepted specifications, such as microazotometers, spirits measuring flasks, etc., will be tested on a cost basis in accordance with 2026.15z. (Report of test will include capacities at test points if appropriate.)	
202.615z	For special calibrations not covered by above schedules, fees will be determined on a cost basis.	

202.616 Metal volumetric apparatus.

(a) Only those instruments suitable for use as reference standards (see, for example, specifications contained in NBS Monograph 62,[7] Testing of Metal Volumetric Standards) will be accepted for calibration, based on inspection at the Bureau. Calibration consists of determining the value "to contain" or "to deliver" by either gravimetric means or by the use of transfer standards. The item will be marked, and the value determined will be reported, together with a statement concerning the uncertainty, on a National Bureau of Standards Report of Calibration. Fee in accordance with 202.616 (a thru z) applies. Specify "to contain," "to deliver," or both.

(b) Items not accepted for calibration as a result of initial inspection will be returned, fee in accordance with 202.616o being applicable.

(c) Packing and shipping:

(1) The apparatus should be securely packed in cases or packages which will protect against possible damage.

(2) When submitting immersion bottles for calibration, do not include the tank as it is not used in the calibration.

(3) Arrangements for calibration of field standards in excess of 10 gal capacity must be completed before shipping apparatus to the Bureau.

(4) If requested, the zero index or gage scales will be adjusted and sealed to within accepted tolerance specifications. Adjustment of slicker plate type standards should be made by the manufacturer.

Item	Description	Fee
	Calibration "to contain." Fee for calibration "to deliver" is same. For both calibrations, double fee shown.	
202.616a	Slicker plate measures of capacity less than 5 gal, each	$19.00
202.616b	Slicker plate measures of 5 gal capacity, each	25.00
	Adjustments of slicker plate measures to within accepted capacity tolerances, if requested, are done on a cost basis under 202.616z.	
202.616c	$\frac{1}{10}$ ft^3 bottles for use in testing gas meters, each	25.00
202.616d	Cubic foot bottles for use in testing gas meters, each	41.00
202.616e	Portable cubic foot standards (Stillman type)	135.00
202.616f	Field standards of capacity less than 5 gal (graduated neck type), each	19.00
202.616g	Field standards of 5 gal capacity, each	25.00
202.616h	Field standards in excess of 5 gal but less than 50 gal capacity, first 10 gal increment	25.00
202.616i	Each additional 5 gal increment, field standards of 50 gal or more capacity	4.50

[7] NBS Monograph 62, Testing of metal volumetric standards. Price 15 cents. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402 (see p. 103 for order form).

Item	Description	Fee
202.616j	First 50 gal increment	$43.00
202.616k	Each additional 50 gal increment	7.50
202.616l	Each additional 5 gal increment	4.50
202.616m	Calibration of field standards, graduated neck type, at more than one scale point, each additional point	15.00
202.616n	Adjustment of zero index or gage, each	13.00
202.616o	Apparatus disqualified for test, inspection and handling fee, each	7.00
202.616z	For calibration not covered by the above schedule, fees will be charged on a cost basis.	

202.617 Hydrometers.

(a) Hydrometers are considered reference standards. Those instruments conforming with the recommendations on construction contained in NBS Circular 555,[8] Testing of Hydrometers, will be accepted for calibration, acceptance based on inspection at the Bureau.

(b) For the purposes of this fee schedule, the following changes are made in Circular 555[8]:

(1) Hydrometers with duplex scales or flat scales are not considered suitable for use as laboratory standards and will not be accepted for calibration.

(2) The thermometer element of a thermohydrometer will not be calibrated. (See ASTM specification E100, Standard Specification for ASTM Hydrometers.)

(3) The results of calibration will be furnished together with a statement of uncertainty, on a National Bureau of Standards Report of Calibration. Use as a laboratory standard implies the use of corrections; therefore no reference to tolerance compliances will be made on the report.

(c) Calibration consists of comparison at three or more points with a standard hydrometer. Fee in accordance with 202.617 applies.

(d) Apparatus not accepted for calibration will be returned, appropriate inspection and handling fee being applicable. Each scale card must state the name of the manufacturer and his serial number, the standard temperature and type of scale.

Item	Description	Fee
202.617a	Hydrometers, calibrated at three points, lots of 10 or more of identical scale range and design, each	$13.00
202.617b	Hydrometers, calibrated at three points, lots of less than 10, each of identical range and design, each	16.00

[8] NBS Circular 555, Testing of hydrometers. Price 10 cents. Available from Superintendent of Documents, U.S. Government Printing Office, Wasbington, D.C., 20402; also in NBS Handbook 77, Precision Measurement and Calibration, Vol. III, Optics, Metrology, and Radiation, p. 707 (see pp. 101 and 103 for price information and order form).

Item	Description	Fee
202.617c	Calibration at additional points, each point	$3.50
202.617d	Hydrometers disqualified for calibration—inspection and handling charge	3.00
202.617z	For special calibrations not covered by the above schedule, fees will be determined on a cost basis.	

202.618 Density determinations of solids and liquids.

(a) If the need is critical and the service is not available elsewhere, request may be accepted for the following density determinations:

(1) Density of solids, determined by hydrostatic weighing in appropriate liquid. Solids generally to have a mass less than 175 g and a maximum dimension less than 15 cm.

(2) Density of liquids, determined by weighing in picnometers at temperatures between 0 and 70 °C.

(3) Associated tests such as the volume of solids, coefficient of thermal expansion for both solids and liquids.

(b) Acceptance for test is based on consultation or correspondence regarding the exact nature of the requirements. Do not ship materials to the Bureau until all arrangements for test have been completed. Fees for all tests are computed on a cost basis.

Item	Description	Fee
202.618z	Density determinations for solids and liquids, fees computed on a cost basis.	

Part 203—Heat

Temperature Physics

Sec.

203.101 Laboratory thermometers
203.102 Thermocouples, thermocouple materials, and pyrometer indicators
203.103 Resistance thermometers
203.104 Clinical thermometers
203.105 Optical pyrometers and ribbon filament lamps

Temperature Physics

203.101 Laboratory thermometers. Only thermometers identified uniquely by serial number will be accepted for test.

Item	Description	Fee
203.101a	Thermometers, testing at points from 0 to 100 °C inclusive, or from 32 to 212 °F inclusive, for each point tested	$10.00

Item	Description	Fee
203.101b	Thermometers, testing at points from 101 to 300 °C inclusive, or from 213 to 600 °F inclusive, for each point tested	$18.00
203.101c	Thermometers, testing at points from 301 to 500 °C inclusive, or from 601 to 950 °F inclusive, for each point tested	30.00
203.101d	Thermometers, testing at points from −1 to −110 °C inclusive, or from 31 to −166 °F inclusive, for each point tested	32.00
203.101e	Thermometers, testing in liquid air, oxygen, or liquid nitrogen (−183 to −196 °C), for each point tested	53.00
203.101f	Calorimeter thermometers	67.00
203.101g	Beckmann thermometers, with 5° or 6° scale, testing at 1° intervals by comparison with precision standards	73.00
203.101h	When instruments submitted are found to be unsuitable for test or unreliable a charge will be made to cover the cost of the work done. Minimum fee	1.00
203.101i	Preliminary examination for foreign material in the mercury column and bulb and for a separated mercury column will be made as required. Separated mercury column will be reunited provided this can be accomplished readily. Maximum fee	3.00
203.101z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

203.102 Thermocouples, thermocouple materials and pyrometer indicators.

(a) Only the bare wires are required in order to perform the thermocouple calibrations in this schedule. It is preferable not to send insulating and protecting tubes, as the rate of breakage of these in shipment is high. If the thermocouple is furnished mounted (as in a protection-tube assembly) a charge of $5.00 will be made for dismantling the mounting, and the various parts will be returned to the sender without reassembling them.

(b) Thermocouple length requirements listed below are exclusive of lead wire. Lead wire need not be sent with thermocouples.

(c) All thermocouple calibration data furnished in reports will be on the basis of a reference junction temperature of 0 °C, or 32 °F.

(d) The calibration or test of an article will not be undertaken if, in our opinion, the article will not yield the specified accuracy, or if it possesses such unusual characteristics as to prevent the carrying out of the calibration or test at a reasonable cost.

Item	Description	Fee
203.102a	High-temperature thermocouples and thermocouple materials. Minimum length 24 in. Corresponding values of emf and temperature at 4 to 15 points in the range 0 to 1450 °C (32 to 2650 °F)----------	$75.00
	The reported uncertainty of calibration of platinum versus platinum-rhodium thermocouples is 0.5 degree Celsius from 0 to 1100 °C and increases from 0.5 degree at 1100 °C to 2 degrees at 1450 °C. Values above 1100 °C are obtained by extrapolation. Results for platinum versus platinum-10% rhodium thermocouples are given at 1 degree intervals over the entire range 0 to 1450 °C. The reported uncertainty of calibration of base-metal thermocouples is 1 degree Celsius. Base-metal thermocouples are not tested above 1100 °C (2000 °F). Thermocouple materials are tested against platinum thermoelectric standards maintained by the Bureau.	
203.102b	High-temperature thermocouples and thermocouple materials. Calibration as per item 203.102a at less than four points, per point------	25.00
203.102c	Platinum versus platinum-10% rhodium thermocouples. The thermocouple shall be at least 36 in. long and made of wire not less than 0.014 in. in diameter. Emf of a thermocouple at any of the following temperatures, per point----------	75.00
	1063 °C (gold point), 960.8 °C (silver point), 630.5 °C 419.5 °C (zinc point). Calibration uncertainty 2 μv (about 0.2 degree Celsius).	
203.102d	Platinum versus platinum-10% rhodium thermocouples. The thermocouple shall be at least 36 in. long and made of wire not less than 0.014 in. in diameter. Primary calibration at all of the temperatures listed in item 203.102c, plus a table of corresponding values of emf and temperature at 1 degree intervals in the range 0 to 1450 °C--	255.00
	Uncertainty in emf reported for the fixed point temperatures 2μv. Uncertainties in values given in the table do not exceed 0.3 degree Celsius in the range 0 to 1100 °C, and then increase from 0.3 degree at 1100 °C to not more than 2 degrees at 1450 °C. If the submitted thermocouple meets the requirements of the International Practical Temperature Scale for standard thermocouples (see the International Practical Temperature Scale of 1948 by H. F. Stimson, J. Res. NBS **65A**, 139, 1961),[9] a quadratic equation fitted at 1063, 960.8, and 630.5 °C will also be furnished.	
203.102e	High-temperature thermocouples and thermocouple materials. Interpolated corresponding values of emf and temperature as per item 203.102a per point----------	2.00
203.102f	Based-metal thermocouples. Minimum length of 36 in. Corresponding values of emf and temperature with an uncertainty of 0.1 °C in the range 0 to −110 °C, per point----------	33.00
	Minimum calibration per thermocouple, two points.	

[9] Also published as NBS Monograph 37, International Practical Temperature Scale of 1948, Text Revision of 1960. Price 10 cents. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402 (see p. 103 for order form).

Item	Description	Fee
203.102g	Base-metal thermocouples. Minimum length of 36 in. Corresponding values of emf and temperature with an uncertainty of about 0.1° in the range 0 to 300 °C and with an uncertainty of about 0.2° above 300 °C, per point	$28.00
	Minimum calibration per thermocouple, two points.	
203.102h	Base-metal thermocouples. Minimum length of 36 in. Corresponding values of emf and temperature with an uncertainty of about 0.1° in the range −183 to −196 °C, per point	48.00
	Minimum calibration per thermocouple, two points.	
203.102i	Pyrometer indicators. Calibration of single scale or meter of single dial of potentiometer (reference junction compensator counting as a dial)	23.00
203.102j	Pyrometer indicators. Calibration of each additional dial of a multi-dial instrument (reference junction compensator counting as a dial) or of each additional range of each dial or scale of a multi-range instrument	8.00
	Calibration of a thermocouple and pyrometer indicator as a unit will be charged for as if the thermocouple and indicator were separately calibrated.	
203.102z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

203.103 Resistance thermometers. Resistance thermometers will normally be tested only if they may reasonably be expected to meet the requirements as a standard on the International Practical Temperature Scale. In general, this requires a four-lead resistor of very pure platinum hermetically sealed in a protecting tube.

Item	Description	Fee
203.103a	Standard platinum resistance thermometers—calibration at the ice, steam and sulfur points. Table will be furnished with entries at 1-degree intervals	$165.00
203.103b	Standard platinum resistance thermometers—calibration under 203.-103a and at the oxygen point. Table will be furnished with entries at 1-degree intervals	220.00
203.103c	Calorimetric type platinum resistance thermometers—calibration at the ice and steam points and at approximately 50 °C. Table will be furnished with entries at 1-degree intervals	165.00
203.103d	Capsule-type platinum resistance thermometers—comparison calibration over the range from 12 to 90 °K. Results will be in the form of a table with entries at 0.1-degree intervals. Additional tables are not available unless requested at the time of test. See item 203.103f	440.00

Item	Description	Fee
203.103e	Determination of the average temperature coefficient of electrical resistance over the interval 0 to 100 °C. Minimum length, 16 in. Samples must have a resistance of at least 0.1 ohm per foot at the ice point----	$70.00
203.103f	Each additional table expressing the results of test under items 203.103 a, b, or c----------	30.00
	Additional tables under item 203.103d are not available unless requsted at the time of test.	
203.103g	Item 203.103f if requested at the same time as the test of the thermometer under items 203.103a, b, c, or d----------	25.00
203.103h	Capsule-type platinum resistance thermometers—mounting this type of thermometer for test under item 203.103 a or b. Not applicable to item 203.103d----------	10.00
203.103y	When instruments submitted are found to be unsuitable for test or unreliable, a charge will be made to cover the cost of the work done.	
203.103z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

203.104 Clinical thermometers.

Item	Description	Fee
203.104z	Test of clinical thermometers for compliance with the current edition of the Commercial Standard for Clinical Thermometers. Fees will be charged dependent upon the time required for making the test.	

203.105 Optical pyrometers and ribbon filament lamps.

(a) Optical pyrometers and ribbon filament lamps submitted for calibration should be accompanied by an order requesting the test and specifying the fee schedule item number. If desired, the calibration points may be specified. A bill will be rendered at the completion of the work.

(b) The calibration of an article will not be undertaken if it possesses such unusual characteristics as to prevent the carrying out of the calibration at a reasonable cost. If, in the course of a calibration, the device is found to behave abnormally, work may be discontinued and a fee covering the cost of the work performed will be charged.

Item	Description	Fee
203.105a	Optical pyrometers: Calibration of one range between 800 and 2400 °C or the first range, between 800 and 2400 °C, of a calibration involving more than one range; 4 to 12 values	$185.00
203.105b	Optical pyrometers: Calibration of ranges in addition to item 203.105a up to 4200 °C; 4 to 12 values in each range, per range	120.00
203.105c	Optical pyrometers: Three or fewer values, 800 to 2400 °C	95.00
203.105d	Ribbon filament lamps: Values of brightness temperature (at wavelength of 0.65μ) versus direct current at 6 to 16 points in the range, 800 to 2300 °C	165.00
203.105e	Ribbon filament lamps: Values of brightness temperature (at wavelength of 0.65μ) versus direct current at five or fewer points in the range, 800 to 2300 °C	90.00
203.105f	Additional interpolated values as per item 203.105a and 203.105b, per point	2.25
203.105z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

Part 204—Radiation Physics

Radioactivity

Sec.

204.201 Calibration of gamma-emitting radioactive samples
204.202 Calibration of alpha-emission rate of sources
204.203 Calibration of beta-emitting radioactive samples

Radiological Equipment—Gamma-Ray Sources

204.501 X-ray and gamma-ray instruments
204.502 Gamma-ray sources

Neutron Physics

204.701 Neutron sources
204.702 Neutron instruments
204.703 Neutron irradiation of foils

Radioactivity

204.201 Calibration of gamma-emitting radioactive samples that conform to the physical, chemical, and activity level specifications for measurement in the Bureau's gamma ionization chamber.

Item	Description	Fee
204.201a	(1) 100 to 300 μg of radium calibrated in terms of micrograms of radium content measured relative to the National Radium Standard----	$63.00
	(2) Chemically stable solutions of the following radionuclides in the specified activity ranges can be measured----------	63.00
	i. 50 to 100 microcuries of sodium 22, sodium 24, scandium 46, cobalt 60, yttrium 88.	
	ii. 150 to 300 microcuries of manganese 54, iron 59, zinc 65, strontium 85, niobium 95, iodine 131, cesium-barium 137, tantalum 182, gold 198, mercury 203.	
	iii. 300 to 600 microcuries of potassium 42, cobalt 57.	
	Solution should be 5 ml in volume and flame-sealed in a glass vial or ampoule of o.d. 16.0$\pm$0.5 mm, wall thickness approximately 0.5 mm.	
204.201b	Chemically stable solutions of the following radionuclides in the specified activity ranges can be measured----------	80.00
	i. 10 to 20 microcuries of sodium 22, sodium 24, scandium 46, cobalt 60, yttrium 88.	
	ii. 30 to 60 microcuries of manganese 54, iron 59, zinc 65, strontium 85, niobium 95, iodine 131, cesium-barium 137, tantalum 182, gold 198, mercury 203.	
	iii. 60 to 100 microcuries of potassium 42, cobalt 57.	
	Solution should be 5 ml in volume and flame-sealed in a glass vial or ampoule of o.d. 16.0$\pm$0.5 mm, wall thickness approximately 0.5 mm.	
204.201z	For special tests not covered by the above schedule, advance arrangements must be made. Fees will be charged dependent on the time involved in making the tests.	

204.202 Calibration of alpha emission rate of sources.

Item	Description	Fee
204.202a	Calibration of alpha emission rate of sources submitted for test-------	$51.00

204.203 Calibration of beta-emitting radioactive samples that conform to the physical, chemical, and activity level specifications for measurement in the Bureau's $2\pi\beta$-windowless proportional flow counter, or in the Bureau's $2\pi\beta$-ionization chamber.

Item	Description	Fee
204.203a	Chemically stable solutions of the following radionuclides in the specified activity ranges can be measured----------	$158.00

Item	Description	Fee
	i. 0.5 to 2 microcuries/ml, strontium-yttrium 90. ii. 1 to 5 microcuries/ml, chlorine 36, thallium 204. iii. 3 to 10 microcuries/ml, sulfur 35, calcium 45, promethium 147. Solution should be approximately 5 ml in volume and flame-sealed in glass vial or ampoule.	
204.203b	Chemically stable solutions of the following radionuclides in the specified activity ranges can be measured i. 0.3 to 3 microcuries/ml, phosphorus 32. Solution should be approximately 5 ml in volume and flame-sealed in a glass vial or ampoule.	$90.00
204.203z	For special tests not covered by the above schedule, advance arrangements must be made. Fees will be charged dependent on the time involved in making the tests.	

Radiological Equipment—Gamma-Ray Sources

204.501 X-ray and gamma-ray instruments

NOTE: Calibration of radiation beam within ± 2 percent.

Item	Description	Fee
204.501a	Calibration of one X-ray exposure-indicating instrument of one range, in international roentgens for lightly or moderately filtered X-rays of one half-value layer from the following selections	$48.00

Lightly filtered X-rays

Technique	kvcp	Approx. inherent filter	Added filter	Distance	Approx. first half-value layer	Homogeneity coefficient (1st HVL/2d HVL)	Instrument range from zero		Exposure rate	
							min.	max.	min.	max.
		mm Be	*mm* Al	*cm*	*mm* Al		*R*	*R*	*R/min*	*R/min*
LFD	20	0.25	0	50	0.06	0.42	100	500	50	200
LFD	20	.25	0	70	.07		50	100	20	80
LFD	20	.25	0	100	.08		25	50	7	30
LFE	20	.25	0.5	50	.20	.68	10	100	2	8
LFG	30	.25	.5	50	.33	.67	25	250	5	20
LFI	50	.25	1.0	50	.90	.68	25	250	6	25
LFK	75	.25	1.5	50	1.6	.66	25	250	10	22
LFM	100	.25	2.0	50	2.5	.63	25	250	14	25

Moderately filtered X-rays

Technique	kvcp	Approx. inherent filter	Added filter		Approx. first half-value layer		Homogeneity coefficient (1st HVL/2d HVL)	Instrument range from zero		Exposure rate	
			Cu	Al	Cu	Al		min.	max.	min.	max.
		mm Al	*mm*	*mm*	*mm*	*mm*		*R*	*R*	*R/min*	*R/min*
MFB	60	1.5	0	0	------	1.64	0.67	5	100	0.4	3.0
MFC	60	1.5	0	2.5	0.09	2.79	.77	5	100	.4	2.5
MFE	75	1.5	0	2.5	.11	3.41	.73	5	100	.4	4.0
MFG	100	1.5	0	3.5	.20	5.05	.73	5	100	.9	6.0
MFI	150	1.5	.25	3.5	.66	10.1	.87	5	100	1.0	8.0
MFK	200	1.5	.5	3.5	1.26	13.2	.92	10	250	2.0	13.0
MFM	250	1.5	1.0	3.5	2.17	16.2	.94	10	250	2.5	17.0
MFO	250	1.5	3.2	3.5	3.20	18.4	.98	10	250	1.3	10.0

Item	Description	Fee
204.501b	Calibration of each additional X-ray exposure-indicating instrument of the same range and for the same half-value layer of lightly or moderately filtered X-rays as selected under 204.501a and not requiring a change in setup and when the instruments are submitted at the same time	$18.00
204.501c	Calibration of one X-ray instrument, either exposure- or exposure-rate-indicating, in international roentgens for heavily filtered X-rays of one effective energy from the following selections	60.00

*Heavily filtered X-rays**

Technique	kvcp	Approx. inherent filter	Added filter				Approximate			Instrument range from zero		Exposure rate	
			Pb	Sn	Cu	Al	Effective energy	HVL	HVL	min.	max.	min.	max.
		mm Al	*mm*	*mm*	*mm*	*mm*	*kev*	*mm* Cu	*mm* Al	*R*	*R*	*R/min*	*R/min*
HFC	50	1.5	.12	0	0	2.5	40	0.16	4.4	0.1	1	0.02	0.09
HFE	100	1.5	.53	0	0	2.5	70	.72	11.2	.1	5	.05	.27
HFG	150	1.5	0	1.5	4.0	2.5	120	2.4	16.8	.1	5	.04	.22
HFI	200	1.5	.7	4.0	0.6	2.5	170	4.1	19.5	.1	5	.03	.21
HFK	250	1.5	2.7	1.0	.6	2.5	215	5.4	21.5	.1	5	.03	.21

* Available on special arrangement.

Item	Description	Fee
204.501d	Calibration of each additional X-ray instrument of the same exposure or exposure-rate range, for heavily filtered X-rays of one effective energy as selected under 204.501c, not requiring a change in setup and when the instruments are submitted at the same time	$24.00

Item	Description	Fee
204.501e	Calibration of one instrument: (1) Exposure-rate-indicating instrument for exposure rates ranging from 0.01 to 15 R/min; or (2) Exposure-indicating instrument of range 0 to 0.1 R to 0 to 25 R, in international roentgens for cobalt 60 or cesium 137 gamma-rays	$42.00
204.501f	Calibration of each additional instrument having the same exposure or exposure-rate range for cobalt 60 or cesium 137 gamma-rays, as under 204.501e, when the instruments are submitted at the same time	17.00
204.501z	Calibration of one X-ray or gamma-ray instrument, exposure- or exposure-rate-indicating, in international roentgens: (1) Calibration of higher accuracy than that routinely furnished; or (2) Calibrations on X-rays of energies other than those listed under 204.501a, c, or e; or (3) Calibrations requiring a special setup or special procedures. Fees will be charged dependent upon the nature of the test. Only a limited number of special calibrations can be undertaken and requests for such should be submitted with full details for consideration.	

204.502 Gamma-ray sources. Radioactive preparations submitted to the Bureau for test are subject to the following conditions:

(a) Financial responsibility: The Bureau assumes no responsibility for loss or damage to radioactive preparations while in its possession. The risk should be covered by insurance.

(b) Period of measurement: Approximately 10 days are required for measurement of these radioactive preparations.

(c) Preparation of specimens: Radioactive preparations submitted for test must be carefully sealed so that there can be no escape of any radioactive material, including any gaseous decay products. The preparations, shielding, and packaging must be free of contamination. Contaminated or leaking preparations cannot be measured and may cause considerable loss of time and damage to laboratory facilities. Preparations must have been sealed for a sufficient time to be substantially in radioactive equilibrium with their decay products when these contribute to the gamma emission (at least 30 days for radium).

(d) Packaging for shipment: Regulations of the Interstate Commerce Commission regarding the shipment of radioactive substances by rail must be complied with. These regulations are enforceable by law and prospective shippers of these substances need to be familiar with them. Copies of the regulations can be obtained from the Interstate Commerce Commission, Washington, D.C., 20423.

(e) Possession of licensed material: In submitting specimens of cobalt 60 or other licensed source material (except radium, which is not licensed) for calibration, it will be necessary for the submitter to certify that he is duly authorized to possess the material under license by the USAEC, except in the case of individuals residing in a State which has entered into agreement with the USAEC, in which case State regulations are applicable. This certification may be by letter, by a suitable statement on the purchase order covering the calibration fee, or by a clear copy of the submitter's Possession License for the source material.

(f) Type of measurements:

(1) Radium is calibrated in terms of milligrams of equivalent radium content measured relative to the National Radium Standard through comparison of the gamma radiation from the specimen and the standard. Where the details of encapsulation of the specimen are known, corrections can be made to obtain milligrams of radium content. Cobalt 60 is calibrated in terms of exposure rate, milliroentgens per hour at one meter, based upon comparison with derived standards of cobalt 60.

(2) Postal regulations prohibit mailing radioactive materials which require a caution label under ICC regulations. This effectively prohibits placing radioactive preparations in the mail.

Item	Description	Fee
	Gamma-ray measurements of radioactive preparations; measurements of milligrams equivalent content to ±0.7 percent for radium; and milliroentgens per hour at one meter to ±3 percent for cobalt 60:	
204.502a	0.5 to 15 mg equivalent radium content or cobalt 60 having gamma-rays 0.5 to 15 mRhm (milliroentgens per hour at one meter)_____	$18.00
204.502b	15+ to 100 mg equivalent radium content or cobalt 60 having gamma-rays 15+ to 100 mRhm_____	28.00
204.502c	100+ to 250 mg equivalent radium content or cobalt 60 having gamma rays 100 to 200 mRhm_____	40.00
204.502d	For measurements in groups not exceeding 10 preparations, double the fee for preparations of same content as the total content of the group.	
204.502e	For handling and examination of a shipment containing contaminated or leaking preparations the fee will be the same as for measurements of a preparation having a content equal to the total nominal radioactive content of the shipment.	
204.502z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test. As only a limited number of special tests can be carried out, prior arrangements must be made including submission of full details concerning the required test.	

Neutron Physics

204.701 Neutron sources.

Item	Description	Fee
204.701a	Determination of ratio of neutron emission rate of unknown source to primary standard in $MnSO_4$ bath or graphite column_____	$385.00

204.702 Neutron instruments.

Item	Description	Fee
204.702a	Calibration of a set (one to three) of thermal neutron dosimeters_____	$78.00

204.703 Neutron irradiation of foils.

Item	Description	Fee
204.703a	Activation of a set (one to four) of foils in the NBS standard thermal neutron flux geometry	$59.00

Part 205—Analytical and Inorganic Chemistry

Pure Substances

205.101 Measurement of physical properties of primary reference fuels used for octane number determination.

Item	Description	Fee
205.101a	Measurement of physical properties of primary reference fuels used for octane number determination	$445.00

Part 206—Mechanics

Vibration

Sec.
206.001 Vibration pickups

Sound

206.101 Acoustic measurements

Pressure and Vacuum

206.201 Pressure measurements

Fluid Mechanics

206.301 Aerodynamical measurements
206.302 Fluid meters, including gas-measuring instruments

Engineering Mechanics

206.401 Hardness tests
206.402 Calibration of load cells with remote-reading electrical indicators
206.403 Special mechanical tests of devices, materials, and structures
206.404 Calibration of proving rings
206.405 Calibration of elastic force measuring devices

Vibration

206.001 Vibration pickups.

(a) This applies to the calibration of displacement, velocity, and acceleration types of vibration pickups. A report of calibration is issued.

(b) Each piezoelectric acceleration pickup which is used with a cathode-follower or amplifier shall be accompanied by the cathode-follower or amplifier, the power supply if other than batteries, and the output and connecting cables.

(c) Each piezoelectric acceleration pickup whose output is read directly with a high-impedance meter can be but need not be accompanied by the meter, but shall be accompanied by the output cable and a suitable shielded connector.

(d) When instruments submitted are found to be unsuitable for test or unreliable, a charge will be made to cover the cost of the work done.

Item	Description	Fee
206.001a	Static calibration on a tilting support in the earth's gravitational field for accelerations up to 1 g, the acceleration of gravity, with an error not greater than 0.001g. Calibration for 10 different applied accelerations	$86.00
206.001b	Static calibration on a centrifuge at four different applied accelerations up to 80 g for not more than two orientations with an estimated error not greater than 0.2 percent of the applied acceleration (eight calibration points). Acceleration will be determined at radii measured to designated reference points on the pickup case	120.00
	For additional tests or measurements required to determine location of seismic mass, fees will be charged to cover the cost of work done.	
206.001c	Dynamic calibration of velocity pickups weighing up to 2 lb in the frequency range from 10 to 2,000 c/s at double displacement amplitudes up to 0.4 in. or accelerations up to 10 g, whichever is less. The pickup is subjected to sinusoidal motion on an electrodynamic vibration standard previously calibrated by the reciprocity method. The estimated errors of the applied accelerations do not exceed 1 percent for frequencies up to 900 c/s and 2 percent above 900 c/s. The magnitude and phase angle of the calibration factor are determined at up to 10 frequencies. The magnitude of the calibration factor is determined for up to three accelerations at each frequency (up to 30 calibration points)	275.00
	For each test frequency in excess of 10, an additional charge equal to one-tenth of the fee is made.	
206.001d	Dynamic calibration of acceleration and displacement pickups weighing up to 2 lb in the frequency range of 10 to 2,000 c/s at double displacement amplitudes up to 0.4 in. or accelerations up to 10 g, whichever is less. The pickup is subjected to sinusoidal motion on an electrodynamic vibration standard previously calibrated by the reciprocity method. The estimated errors of the applied accelerations do not exceed 1 percent for frequencies up to 900 c/s and 2 percent above 900 c/s. The magnitude and phase angle of the calibration factor are determined at up to 10 frequencies. The magnitude of the calibration factor is determined for up to three accelerations at each frequency (up to 30 calibration points)	350.00
	For each test frequency in excess of 10, an additional charge equal to one-tenth of the fee is made.	

Item	Description	Fee
206.001e	Dynamic calibration of piezoelectric acceleration pickups weighing up to 4 oz in the frequency range of 10 to 2,000 c/s at double displacement amplitudes up to 0.4 in. or accelerations up to 10 g, whichever is less or if requested, up to 20 g at two unspecified frequencies. The pickup is subjected to sinusoidal motion on an electrodynamic vibration standard previously calibrated by the reciprocity method. The estimated errors of the applied accelerations do not exceed 1 percent for frequencies up to 900 c/s and 2 percent above 900 c/s. The magnitude of the calibration factor is determined for up to three accelerations at up to 10 frequencies within a specified range (up to 30 calibration points)---------- For each test frequency in excess of 10, an additonal charge equal to one-tenth of the fee is made.	$255.00
206.001z	For special tests not covered by the above schedule, such as dynamic calibrations of pickups weighing more than 2 lb, calibrations of small, lightweight piezoelectric ceramic pickups over an extended frequency range up to 20,000 c/s, or calibrations at higher accelerations, fees will be charged dependent on the nature of the test.	

Sound

206.101 Acoustic measurements.

Item	Description	Fee
206.101a	Pressure calibration of Western Electric Co. Type 640AA condenser microphone or equivalent from 50 to 10,000 c/s at discrete frequencies. Response given in terms of open-circuit voltage per unit sound pressure applied to the microphone----------	$205.00
206.101b	Pressure calibration of Western Electric Co. Type 640AA condenser microphone or equivalent from 50 to 20,000 c/s at discrete frequencies. Response given in terms of open-circuit voltage per unit sound pressure applied to the microphone----------	280.00
206.101c	Free-field calibration of microphone satisfying the requirements of the Type-L laboratory microphone specified in American Standards Association Standard Z24.8–1949; 50 to 15,000 c/s at discrete frequencies; plane of diaphragm either perpendicular or parallel to the direction of sound propagation. Response given in terms of open-circuit voltage per unit free-field sound pressure----------	280.00
206.101d	Calibration of earphones; applied voltage response as prescribed in the American Standards Association Specification Z24.9–1949, at not more than 20 frequencies between 100 and 10,000 c/s----------	320.00
206.101e	Calibration of pure tone audiometers for screening purposes at nine fixed frequencies----------	820.00

Item	Description	Fee
206.101f	Artificial ear at audiometric frequencies	$430.00
206.101g	Sound absorption coefficient, obtained by reverberation room method, using 72 ft^2 of material at frequencies of 125, 250, 500, 1,000, 2,000, and 4,000 c/s In case of tests on acoustical plasters or paintability tests, any construction work or painting done by the Bureau is charged to the sponsor in addition to the fee given above.	430.00
206.101h	Sound absorption coefficient by impedance tube method at 500 c/s in the laboratory on acoustical tiles	110.00
206.101i	Sound transmission loss, wall panel, 71 in. × 88 in. at frequencies of 125, 175, 250, 350, 500, 700, 1,000, 1,500, 2,000, 3,000, and 4,000 c/s The construction of the wall panel is the responsibility of the sponsor of the test.	430.00
206.101j	Sound transmission loss, floor panel, 71 in. × 88 in. at frequencies of 125, 175, 250, 350, 500, 700, 1,000, 1,500, 2,000, 3,000, and 4,000 c/s plus impact sound transmission The construction of the floor panel is the responsibility of the sponsor of the test.	575.00
206.101z	For special tests not covered by the above schedule, fees will be charged dependent on the nature of the test.	

Pressure and Vacuum

206.201 Pressure measurements.

Item	Description	Fee
206.201a	Deadweight piston gages other than controlled clearance gages (also called deadweight gage testers and pressure balances). Determination of effective area of the piston by comparison with a pressure standard, up to five test points at room temperature, 20 to 25 °C. Pressure fluid may be air, up to 600 psi, petroleum oil up to 60,000 psi, or synthetic lubricant (dioctyl sebacate) up to 120,000 psi. Determination of effective area requires previous weighing of piston assembly and the use of calibrated weights. If the Bureau has weights to fit, the gage may be calibrated using NBS weights. For each piston	$285.00
206.201b	Controlled clearance piston gages. Determination of effective area, jacket pressure for zero clearance and variation of effective area with jacket pressure. Test is made on an assembly of piston, cylinder and jacket, not to be disassembled later. Determination of effective area requires previous weighing of piston assembly and the use of calibrated weights. If the Bureau has weights to fit, the gage may	

Item	Description	Fee
	be calibrated using NBS weights. Inquiry should be made as to the parts to be submitted. Fee usually does not exceed $1,000.00. Work to be charged at cost.	
206.201c	Barometers, Fortin or similar types, range 28 to 31 in. Hg, tube bore 0.5 in. or greater, calibration at room temperature (20 to 25 °C) and atmospheric pressure	$220.00
206.201d	Manometers, manually operated, with tube bore 0.5 in. or greater, in which both mercury surfaces are observed. Range to 100 in. Hg, calibration test at room temperature (20 to 25 °C) up to ten test points. Fee usually does not exceed $1,000.00. Work to be charged at cost.	
206.201e	Manometers, with tube bore 0.5 in. or greater, in which both mercury surfaces are observed, and of design which permits calibration in terms of length, temperature, etc. Calibration of scale and thermometer, performance verified by comparison with pressure standard. Fee usually does not exceed $1,000.00. Work to be charged at cost.	
206.201z	For special tests not covered by the above schedule. For example, calibration of pressure gages of high precision and stability. Work to be charged at cost.	

Fluid Mechanics

206.301 Aerodynamical measurements.

Item	Description	Fee
206.301a	Wind-speed indicators—calibration of cup, vane, and thermal type anemometers, pitot tubes, and venturi tubes at wind speeds within the range 2 to 90 mph or (optional) 10 to 170 mph	$83.00
206.301z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

206.302 Fluid meters, including gas-measuring instruments.

Item	Description	Fee
206.302a	Dry gas meters, rated capacity 600 ft^3/hr or less—testing with prover in laboratory at two rates of flow and reporting	$60.00
206.302b	Displacement type meters for liquids which can be calibrated with water at rates of flow not exceeding 300 gpm—testing at one to five rates of flow and reporting	180.00

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Item	Description	Fee
206.302c	Rate of flow meters, self-contained and direct reading; for gases, capacities not over 25 cfm; for liquids, capacities not over 300 gpm—calibration at not more than five rates of flow and reporting	$295.00
206.302d	Orifices, flow nozzles, laminar flow meters, and similar differential head meters for use in pipes up to and including 2-in. pipe; calibration with water or air at a number of flow rates sufficient to develop a performance curve	430.00
206.302e	Additional fee for meter in pipes larger than those included in item 206.302d—for each 1-in. increment of size over 2 in	28.00
206.302f	Meters listed in item 206.302d, when two or more are used interchangeably in the same mounting—for each meter or orifice plate after the first	130.00
206.302g	Water current meters—rating of Price, Pigmy, and Hoff types at not over eight velocities, and reporting results in equation form only, or in graph form only	43.00
206.302h	Water current meters—rating of Hoff type at 10 or 11 velocities and reporting results in both graphical and equation forms, for each propeller	56.00
206.302i	Water current meters—Ekman type, for each propeller submitted therewith; rating at not over eight velocities and reporting results in both graphical and equation form	120.00
206.302j	Water current meters—all types, for each velocity in excess of the number covered by items 206.302g to 206.302i above	5.00
206.302k	Furnishing results of water current meter calibration in graphical form, or in equation form when requested subsequent to completion of test	11.00
206.302z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

Engineering Mechanics

206.401 Hardness tests.

Item	Description	Fee
206.401a	Determination of Brinell number of a block to be used for calibration purposes, three separate indentations on each specimen	$41.00

206.402 Calibration of load cell with remote-reading electrical indicators.

(a) These fees apply to calibration of load cells with remote-reading electrical indicators.

(b) Individual load cells or load cell systems must be accompained by readout or indicating equipment and all associated cables and fixtures.

(c) Up to 10 different loads are applied consecutively without return to zero.

(d) For each load in excess of 10, an additional fee equal to one-tenth of the applicable fee is charged.

(e) When devices submitted are found to be unsuitable for test or unrealiable, the test may be discontinued and a charge will be made to cover the cost of the work done.

Item	Description	Fee
	Capacity not exceeding 10,000 lb:	
206.402a	Compression	$70.00
206.402b	Tension	81.00
206.402c	Tension and compression	125.00
	Capacity exceeding 10,000 lb but not exceeding 111,000 lb:	
206.402d	Compression	87.00
206.402e	Tension	120.00
206.402f	Tension and compression	165.00
	Capacity exceeding 111,000 lb but not exceeding 200,000 lb:	
206.402g	Compression	255.00
	Capacity exceeding 200,000 lb but not exceeding 300,000 lb:	
206.402h	Compression	300.00
206.402z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

206.403 Special mechanical tests of devices, materials, and structures.

(a) These fees apply to all mechanical tests of devices, materials, and structures performed in the Mechanics Division not covered by other fee schedules.

(b) The charge for special mechanical tests is made on the basis of the hours of service furnished by members of the staff.

(c) Where tests require travel outside the limits of 30 miles from the Bureau, transportation and subsistence charges will be added to the service charge.

(d) The time shall be computed as the number of official working hours from the time the members of the staff leave the Bureau until they return to it plus any overtime spent on the tests.

Item	Description	Fee
206.403a	Service of a member of the staff of grade GS–9, or any higher grade, per hour	$12.00
206.403b	Service of a member of the staff of grades below GS–9, per hour	7.00

206.404 Calibration of proving rings.

(a) These fees apply to calibration of proving rings suitable for use as laboratory or transfer standards.

(b) These fees apply to calibration in accordance with sections I, II, III, and IV of the Appendix of NBS Circular [10] 454.

(c) Up to 10 independent loads for compression or tension are applied.

(d) Fees for complete calibrations apply to rings submitted for initial calibration.

(e) For each load in excess of 10, an additional fee equal to one-tenth of the applicable fee for complete calibration or recalibration is charged.

(f) When devices submitted are found to be unsuitable for test or unreliable, a test may be discontinued and a charge will be made to cover the cost of the work done.

Item	Description	Fee
	Complete calibration of proving rings, capacity not exceeding 10,000 lb:	
206.404a	Compression	$140.00
206.404b	Tension and compression	225.00
	Recalibration of proving rings, capacity not exceeding 10,000 lb:	
206.404c	Compression	98.00
206.404d	Tension and compression	170.00
	Complete calibration of proving rings, capacity exceeding 10,000 lb but not exceeding 111,000 lb:	
206.404e	Compression	175.00
206.404f	Tension and compression	280.00
	Recalibration of proving rings, capacity exceeding 10,000 lb but not exceeding 111,000 lb:	
206.404g	Compression	125.00
206.404h	Tension and compression	230.00

[10] NBS Circular 454, Proving rings for calibration testing machines. In NBS Handbook 77, Precision Measurement and Calibration, Vol. II, Heat and Mechanics, p. 573 (see pp. 101 and 103 for price information and order form).

Item	Description	Fee
	Complete calibration of proving rings, capacity exceeding 111,000 lb but not exceeding 200,000 lb:	
206.404i	Compression	$390.00
	Recalibration of proving rings, capacity exceeding 111,000 lb but not exceeding 200,000 lb:	
206.404j	Compression	280.00
	Complete calibration of proving rings, capacity exceeding 200,000 lb but not exceeding 300,000 lb:	
206.404k	Compression	470.00
	Recalibration of proving rings, capacity exceeding 200,000 lb but not exceeding 300,000 lb:	
206.404l	Compression	345.00
206.404z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

206.405 Calibration of elastic force measuring devices.

(a) These fees apply to calibration of elastic force measuring devices of a type suitable for use as laboratory or transfer standards.

(b) Before a device is accepted for calibration under this schedule it will be inspected for damage, wear, and operability. Loading surfaces, tension adaptors, and pulling rods must be complete and suitable for use with Bureau equipment. The device must be uniquely and permanently marked with the manufacturers' serial numbers and rated capacities.

(c) A temperature coefficient must be supplied by the submitter of the device.

(d) Devices will be overloaded repeatedly to approximately 10 percent in excess of the manufacturers' rated capacity.

(e) Up to 10 different independent loads for compression or tension will be applied.

(f) For each load in excess of 10, an additional fee equal to one-tenth of the applicable fee is charged.

(g) When devices submitted are found to be unsuitable for test or unreliable, a test may be discontinued and a charge will be made to cover the cost of the work done.

Item	Description	Fee
	Capacity not exceeding 10,000 lb:	
206.405a	Compression	$99.00
206.405b	Tension	115.00
206.405c	Tension and compression	175.00

Item	Description	Fee
	Capacity exceeding 10,000 lb but not exceeding 111,000 lb:	
206.405d	Compression	$125.00
206.405e	Tension	175.00
206.405f	Tension and compression	235.00
	Capacity exceeding 111,000 lb but not exceeding 200,000 lb:	
206.405g	Compression	280.00
	Capacity exceeding 200,000 lb but not exceeding 300,000 lb:	
206.405h	Compression	345.00
206.405z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the tests.	

Part 208—Metallurgy

Electrodeposition

208.601 Standard thickness samples of electroplated coatings.

Item	Description	Fee
208.601a	Standard thickness samples of electroplated coatings, set of four samples	$15.00
	Individual samples, each	4.00

Part 210—Building Research

Fire Resistance

Sec.
210.201 Fire resistance tests of building components

Thermal Conductivity

210.601 Thermal conductivity

Fire Resistance

210.201 Fire resistance tests of building components. Requests for tests should be made in writing to the Fire Research Section, National Bureau of Standards, Washington, D.C., 20234, and should be accompanied with detailed drawings and specifications of the structures proposed for test. Tests will be conducted for the public only until adequate facilities become available elsewhere.

Item	Description	Fee
210.201a	Fire endurance test of a floor, roof, or ceiling, 13½×18 ft	$3,850.00
210.201b	Fire endurance test of structural column 13 ft high subjected to load, or without load	3,200.00

Thermal Conductivity

210.601 Thermal conductivity.

Item	Description	Fee
210.601a	Determination for calibration purposes of the thermal conductivity of a selected pair of specimens, by means of guarded hot-plate apparatus (conforming to ASTM C177) for mean temperatures between 20 and 130° F (ordinarily 20, 30, 75, and 130° F), per determination at one mean temperature	$130.00
210.601b	Determination of thermal conductivity of a metal specimen for a range of mean temperatures from −150 to 750° C, per specimen Required sample is a cylindrical bar, 46.0 cm long, and approximately 2.54 cm uniform diameter.	1,625.00
210.601c	Determination of thermal conductivity of a metal specimen for a range of mean temperatures from −150 to 200° C, per specimen Required sample is a cylindrical bar, 46.0 cm long, and approximately 2.54 cm uniform diameter.	1,150.00
210.601d	Determination of thermal conductivity of a metal specimen for a range of mean temperatures from 100 to 750° C, per specimen Required sample is a cylindrical bar, 46.0 cm long, and approximately 2.54 cm uniform diameter.	1,250.00
210.601z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test and time required.	

Part 215—Physical Chemistry

Organic Chemistry

Sec.

215.301 Synthesis of C^{14} labeled sugars and related products
215.302 Synthesis of tritium-labeled carbohydrates

215.301 Synthesis of C^{14} labeled sugars and related products.

Item	Description	Fee
215.301a	Synthesis of 10 microcuries of C^{14} labeled sugars and related products, Type I (carbohydrates labeled at carbon 1)	$12.50
	Each microcurie	1.25
215.301b	Synthesis of 10 microcuries of C^{14} labeled sugars and related products, Type 2 (carbohydrates labeled in positions other than carbon 1)	17.50
	Each microcurie	1.75

215.302 Synthesis of tritium-labeled carbohydrates.

Item	Description	Fee
215.302a	Synthesis of 10 microcuries of tritium-labeled carbohydrates (carbohydrates labeled without extensive alteration of the carbon skeleton)	$12.50

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Publications

NBS publications provide a means of keeping abreast of the Bureau's research programs, and often contain information on standards, calibration, and measurement techniques. The Bureau's publications are: *The Journal of Research of the National Bureau of Standards* (published in four sections), which contains major scientific papers describing NBS research and developments in physics, chemistry, mathematics, and engineering, as well as review articles on subjects related to the Bureau's research program; the *NBS Technical News Bulletin*, a monthly publication containing summary articles concerning all phases of the NBS research program, a list of Bureau publications, and columns on "Standard Materials" and "Standards and Calibration;" Monthly *CRPL Ionospheric Predictions*, which provide data necessary for calculating optimum communication frequencies; and five series of nonperiodicals (Monographs, Applied Mathematics Series, Handbooks, Technical Notes, and Miscellaneous Publications).

Of direct interest to measurement personnel is NBS Handbook 77, *Precision Measurement and Calibration* (issued Feb. 1961). In this Handbook are reprinted some of those publications of NBS staff members most frequently referred to in conferences with persons connected with standards laboratories. This Handbook, published in three volumes—(1) Electricity and Electronics, (2) Heat and Mechanics, and (3) Optics, Metrology, and Radiation—provides a "textbook" and reference source for training in measurement sciences.

Articles by NBS staff members appearing in outside publications are listed regularly in the Journal of Research, the Technical News Bulletin, and the annual Research Highlights of the National Bureau of Standards. In general these articles are available directly from the authors.

The following list contains the title and prices of those documents referred to in the text of this publication. On the reverse of this page is an order blank for all NBS publications.

NBS Circular 3, Design and test of standards of mass (in NBS Handbook 77).
NBS Circular 429, Photoelectric tristimulus colorimetry with three filters (in NBS Handbook 77).
NBS Circular 454, Proving rings for calibrating testing machines (in NBS Handbook 77).
NBS Circular 555, Testing of hydrometers, 10 cents (also in NBS Handbook 77).
NBS Circular 602, Testing of glass volumetric apparatus, 20 cents (also in NBS Handbook 77).
NBS Monograph 37, International Practical Temperature Scale of 1948, text revision of 1960, 10 cents.
NBS Monograph 47, Basic magnetic quantities and the measurement of the magnetic properties of materials, 30 cents.
NBS Monograph 62, Testing of metal volumetric standards, 15 cents.
NBS Handbook 77, Precision measurement and calibration. Three-volume set, $19.75.
Vol. I, Electricity and electronics, $6.00.
Vol. II, Heat and mechanics, $6.75.
Vol. III, Optics, metrology, and radiation, $7.00.
NBS Miscellaneous Publication 236, Standard frequencies from NBS stations WWV and WWVH, 10 cents.
NBS Miscellaneous Publication 241, Standard Materials, 30 cents.

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..... Misc. Publ. 240 (1957–1960), $2.25*

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As services are initiated or discontinued, or fees are changed, announcements will appear in the Federal Register, and major changes will be noted in the Standards and Calibration column of the NBS Technical News Bulletin. The Bureau also plans to issue periodic listings of such changes. If you wish to be placed on a mailing list to receive these inserts as they are issued, please complete the post card below, detach it, and mail to the National Bureau of Standards.

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U.S. DEPARTMENT OF COMMERCE

Luther H. Hodges, *Secretary*

NATIONAL BUREAU OF STANDARDS

A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D.C.

Electricity. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage. Absolute Electrical Measurements.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Volume.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

Polymers. Macromolecules: Synthesis and Structure. Polymer Chemistry. Polymer Physics. Polymer Characterization. Polymer Evaluation and Testing. Applied Polymer Standards and Research. Dental Research.

Metallurgy. Engineering Metallurgy. Metal Reactions. Metal Physics. Electrolysis and Metal Deposition.

Inorganic Solids. Engineering Ceramics. Glass. Solid State Chemistry. Crystal Chemistry. Physical Properties. Crystallography.

Building Research. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials. Metallic Building Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

Data Processing Systems. Components and Techniques. Computer Technology. Measurements Automation. Engineering Applications. Systems Analysis.

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Far Ultraviolet Physics. Solid State Physics. Electron Physics. Atomic Physics. Plasma Spectroscopy.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Elementary Processes. Mass Spectrometry. Photochemistry and Radiation Chemistry.

Office of Weights and Measures.

BOULDER, COLO.

Cryogenic Engineering Laboratory. Cryogenic Processes. Cryogenic Properties of Solids. Cryogenic Technical Services. Properties of Cryogenic Fluids.

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Ionosphere Research and Propagation. Ultra Low Frequency Research. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services. Vertical Soundings Research.

Troposphere and Space Telecommunications. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Spectrum Utilization Research. Radio-Meteorology. Lower Atmosphere Physics.

Radio Systems. Applied Electromagnetic Theory. High Frequency and Very High Frequency Research. Frequency Utilization. Modulation Research. Antenna Research. Radiodetermination.

Upper Atmosphere and Space Physics. Upper Atmosphere and Plasma Physics. High Latitude Ionosphere Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

RADIO STANDARDS LABORATORY

Radio Standards Physics. Frequency and Time Dissemination. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Radio Plasma. Microwave Physics.

Radio Standards Engineering. Coordinator Calibration Service. High Frequency Electrical Standards. High Frequency Calibration Services. High Frequency Impedance Standards. Microwave Calibration Services. Microwave Circuit Standards. Low Frequency Calibration Services.

JOINT INSTITUTE FOR LABORATORY ASTROPHYSICS–NBS GROUP (UNIV. OF COLO.)

U. S. Department Of Commerce
National Bureau of Standards

INSERT SHEET 1
November 10, 1965

CALIBRATION AND TEST SERVICES OF THE
National Bureau of Standards
Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

CHANGE 1.

The following announcement from the *Federal Register* for November , 1965 modifies the information given in paragraph 200.112, p. 10 of MP250, 1965 edition.

Centralization of Low Frequency Calibration Services

In the interest of economy and managerial efficiency, the low frequency calibration services previously available at both Washington and Boulder laboratories of the National Bureau of Standards are being centralized at the Bureau's laboratories in the Washington area. Effective immediately plants shipping low frequency standards to the Bureau should make arrangements for scheduling of their calibration by letter to the Electricity Division, NBS, Washington, D. C. 20234. This Division will be moving from Washington to the new laboratories at Gaithersburg, Maryland in early 1966. Such advance arrangements will minimize delays during the double move and assure that the material reaches the proper location. All items for frequencies in the 0–30 kHz range will be affected, except signal sources (Section 201.701), which will continue to be calibrated at Boulder. No other low frequency work (Sections 201.100 through 201.604) will be scheduled at Boulder after November 18, and material received after that date will be returned, collect, to the sender. Standards received before that date, and which are covered by a valid Purchase Order, will be calibrated so far as possible, in accordance with previously maintained schedules. All calibration services at frequencies greater than 30 kHz (i.e., high frequency and microwave calibration services) will continue to be available only at the Electronic Calibration Center, Radio Standards Laboratory, Boulder Laboratories of the Department of Commerce, Boulder, Colorado 80301.

Title 15—COMMERCE AND FOREIGN TRADE

Chapter II—National Bureau of Standards, Department of Commerce

Subchapter A—Test Fee Schedules. Part 200—General

Under the provisions of 15 U.S.C. 275(a) and 277, the following revision supersedes Section 200.112 issued in the Federal Register of August 13, 1965. The revision provides that low frequency calibration services (0–30 kHz) will hereafter be available only through the facilities of the National Bureau of Standards in Washington.

Section 200.112 Location of Laboratories

The calibrations listed in Parts 202, 203, 204, 205, 206, and 210 of this subchapter and the low frequency electrical calibrations of Parts 201.100 through 201.604 of this subchapter will after July 1, 1966 be performed in the Gaithersburg Laboratories of the National Bureau of Standards whose address is Washington, D. C. 20234. Calibrations of signal sources (Section 201.701) and all electrical standards in the radio frequency region (Parts 201.810 through 201.950 of this subchapter) are performed by the Radio Standards Laboratory of NBS at Boulder, Colorado 80301.

After November 18, 1965, low frequency calibration services will be available only through the Electricity Division in Washington. All requests for such services, and inquiries (giving full details of ranges, frequencies, and electrical burdens) concerning schedules and shipping instructions, should be directed to

Electricity Division
Institute for Basic Standards
National Bureau of Standards
Washington, D. C. 20234

* Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of insert sheet are available from NBS Office of Technical Information and Publications.

(over)

If the apparatus is to be calibrated at both high and low frequencies, arrangements may be initiated with either the Boulder or Washington laboratories. The cost of shipping the apparatus between laboratories will be billed to the client.

CHANGE 2.

The following supplements the information in paragraph 201.821, pp. 36–37 of MP 250, 1965 edition.

Calibration of Coaxial Bolometer Mounts

The Radio Standards Laboratory announces that an additional service is now available for the measurement of the calibration factor** of nominal 50-ohm coaxial bolometer units. The new service provides for calibration at 3 GHz, in addition to the frequencies of 100 MHz and 1 GHz that have been available for a number of months. Measurements are made at the 1 and 10 milliwatt power levels only, with no provision at present for the calibration of bolometer-coupler units.

The limit of uncertainty in determining the calibration factor at 3 GHz is within 1.5% for well-designed bolometer units. Limits of uncertainty may be greater for bolometer units having a VSWR higher than 1.1. The service includes the calibration of both barretter and thermistor types of bolometer units having operating resistances of 50, 100, and 200 ohms.

** The calibration factor of a bolometer unit is defined as the ratio of the substituted d-c power in the unit to the rf power incident upon the bolometer unit.

CHANGE 3.

Delete item 202.114h, p. 58 of MP 250, 1965 edition.

U. S. Department of Commerce
National Bureau of Standards

INSERT SHEET 2
April 15, 1966

CALIBRATION AND TEST SERVICES OF THE
National Bureau of Standards
Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

CHANGE 4.

ATTENTION! The National Bureau of Standards laboratories at Washington, D.C. are now in the midst of a move to new quarters at Gaithersburg, Maryland. To make certain that equipment submitted for calibration reaches the proper laboratory, the following rules should be observed:

(1) Equipment sent by U. S. Mail, and intended for laboratories in Washington or Gaithersburg, should be addressed, as before, to the appropriate laboratory or other local destination, National Bureau of Standards, Washington, D. C. 20234.

(2) Equipment hand carried in for calibration, or sent by railway or air express, should be brought or addressed to the appropriate laboratory or other local destination, National Bureau of Standards, Gaithersburg, Maryland. This applies after May 15, 1966 to all calibration services previously performed at Washington, with the following *exceptions:*

Voltage Ratio and High-Voltage Measurements: schedules 201.601 through 201.604.

Length: schedules 202.401 through 202.412.

Engineering Metrology: schedules 202.500 through 202.509.

Sound: schedule 206.011.

Fluid Meters: schedule 206.311.

Aerodynamics: schedule 206.331.

Until further notice, equipment for the excepted services just listed should be brought or sent to Washington, D. C., as indicated in (1) just above.

(3) In case of doubt, consult the laboratory that performs the calibrations. For the procedure to follow in requesting services, see section 200.103 of MP250.

(4) The NBS laboratories at Boulder, Colorado, are not affected by these changes. As before, equipment to be calibrated at Boulder should be addressed or carried to: Radio Standards Laboratory, National Bureau of Standards, Boulder, Colorado 80301.

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U. S. Department of Commerce
National Bureau of Standards

INSERT SHEET 3
April 15, 1966

CALIBRATION AND TEST SERVICES OF THE
National Bureau of Standards
Notice of Change to NBS Misc. Publ. 250, 1965 Edition

CHANGE 5.

Effective March 28, 1966, a reduction in charges for calibration services in high-frequency and microwave regions (30 kHz and up) has been announced by the Electronic Calibration Center of the NBS Radio Standards Laboratory. Charges previously based on the rate of $30 per hour are now based on a rate of $20 per hour, and charges previously based on $35 per hour are now based on a rate of $25 per hour. This reduction was largely made possible by a reduction now occurring in depreciation costs for Electronic Calibration Center equipment.

CHANGE 6.

In item 202.403z, p. 65 of Misc. Publ. 250, delete the clause: "they may be approximately estimated as one-half of the corresponding fees of schedule 202.402."

CHANGE 7.

Delete the *first* listings of items 201.950a-1 and 201.950z on the upper part of p. 49 of MP250.

CHANGE 8.

The following new schedule is added (on page 45) to those under the general heading, "Microwave Region":

201.912 Continuous low-level measurement of coaxial bolometer units.
See Section 201.910 above for definitions and information on the calibration of bolometer units.

Item	Description	Fee
201.912a	Measurement of effective efficiency of a coaxial bolometer unit at a frequency of 9 GHz, and a power level of 10 mW. Bolometer unit must be fitted with male Type N connector and thermistor-type element of nominal operating resistance of 200 ohms.	(**)

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** See 201.900(h).

CHANGE 9.

Changes have been made in items throughout all schedules listed under "Engineering Mechanics," starting in the middle of p. 102 and ending in the middle of p. 106 of MP250. The changed schedules are those numbered 201.041 to 201.045, inclusive. Instead of detailing each individual change, the revised texts of these schedules, incorporating all modifications, deletions, and additions, are given on the next two Insert Sheets. These can be inserted at the appropriate place in the publication; and the old schedules should be deleted, for example, by drawing diagonal lines through them.

CHANGE 10.

Changes have also been made in most of the fees for items in the Engineering Mechanics schedules (201.041 through 201.045) and fees have been announced for the newly added items. In addition, the fee for item 202.402c has been reduced. All of these are included in the following list. The changes should be entered in the List of Fees, Appendix "C" of MP250.

TABLE 1. List of schedules with the fee changes.

Item	Old Fee	New Fee	Item	Old Fee	New Fee
202.402c	$33.00	$3.00	206.044f	365.00	480.00
			206.044g	165.00	215.00
206.041a	53.00	54.00	206.044h	300.00	335.00
			206.044i	510.00	650.00
206.042a	95.00	150.00	206.044j	365.00	1050.00
206.042b	105.00	165.00	206.044k	610.00	390.00
206.042c	165.00	200.00	206.044l	450.00	760.00
206.042d	115.00	170.00	206.044m	-----	870.00
206.042e	155.00	175.00	206.044n	-----	1425.00
206.042f	215.00	240.00	206.044o	-----	560.00
206.042g	340.00	315.00	206.044p	-----	870.00
206.042h	390.00	340.00			
206.042i	-----	495.00	206.045a	130.00	170.00
206.042j	-----	435.00	206.045b	150.00	180.00
206.042k	-----	470.00	206.045c	230.00	245.00
206.042l	-----	690.00	206.045d	165.00	220.00
			206.045e	230.00	245.00
206.043a	13.00	15.00	206.045f	305.00	335.00
206.043b	8.00	8.00*	206.045g	365.00	380.00
			206.045h	450.00	410.00
206.044a	185.00	205.00	206.045i	-----	690.00
206.044b	295.00	330.00	206.045j	-----	510.00
206.044c	130.00	150.00	206.045k	-----	580.00
206.044d	220.00	205.00	206.045l	-----	880.00
206.044e	230.00	295.00			

* No change.

CALIBRATION AND TEST SERVICES OF THE
National Bureau of Standards
Notice of Change to NBS Misc. Publ. 250, 1965 Edition**

CHANGE 9. This Insert Sheet and the one following contain the revised texts of schedules 201.041 through 201.045. The two sheets should be inserted after p. 102 of MP250, and the old schedule should be deleted.

Engineering Mechanics

206.041 Hardness tests.

Item	Description	Fee
206.041a	Determination of Brinell number of a block to be used for calibration purposes, 3 separate indentations on each specimen.	(*)

* For current fees, see Change 10 on Insert Sheet 3.

206.042 Calibration of load cells with remote reading electrical indicators.

(a) Individual load cells or load cell systems must be accompanied by readout or indicating equipment and all associated cables and fixtures.

(b) For the fee quoted, calibration will be made on one machine with up to 10 incremental loads applied consecutively without return to zero load. For each load in excess of 10, an additional fee equal to one-tenth of the applicable fee will be charged. For any device requiring the use of more than one machine, a charge will be made covering the cost of the additional work involved.

(c) When devices submitted are found to be unsuitable for test or unreliable, the test may be discontinued and a charge will be made to cover the cost of the work done.

Item	Description	Fee
	Capacity not exceeding 10,000 lb:	
206.042a	Compression	(*)
206.042b	Tension	(*)
206.042c	Tension and compression	(*)
	Capacity exceeding 10,000 lb but not exceeding 112,000 lbs:	
206.042d	Compression	(*)
206.042e	Tension	(*)
206.042f	Tension and compression	(*)
	Capacity exceeding 112,000 lb but not exceeding 300,000 lb:	
206.042g	Compression	(*)
206.042h	Tension	(*)
206.042i	Tension and compression	(*)
	Capacity exceeding 300,000 lb but not exceeding 1,000,000 lb:	
206.042j	Compression	(*)
206.042k	Tension	(*)
206.042l	Tension and compression	(*)
206.042z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

* For current fees, see Change 10 on Insert Sheet 3.

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206.043 Special mechanical tests of devices, materials and structures.

(a) These fees apply to all mechanical tests of devices, materials and structures performed in the Mechanics Division not covered by other fee schedules.

(b) The charge for special mechanical tests is made on the basis of the hours of service furnished by members of the staff.

(c) The time shall be computed as the number of official working hours from the time the members of the staff leave the National Bureau of Standards until they return to it plus any overtime spent on the tests.

(d) Where tests require travel outside the limits of 30 miles from the Bureau, transportation and subsistence charges will be added to the service charge.

Item	Description	Fee
206.043a	Service of a member of the staff of grade GS-9, or any higher grade, per hour--	(*)
206.043b	Service of a member of the staff of grades below GS-9, per hour----------	(*)

* For current fees, see Change 10 on Insert Sheet 3.

206.044 Calibration of proving rings.

(a) These fees apply to calibration or recalibration of proving rings suitable for use as laboratory or transfer standards in accordance with Sections I, II, III, and IV of the appendix of NBS Circular 454.[23]

(b) For the fee quoted, calibration will be made on one machine with up to 10 independent loads for compression or tension applied. Fees for complete calibrations apply to rings submitted for initial calibration. For each load in excess of 10, an additional fee equal to one-tenth of the applicable fee for complete calibration or recalibration is charged. For any device requiring the use of two or more machines, a charge will be made covering the cost of the additional work involved.

(c) When devices submitted are found to be unsuitable for test or unreliable, a test may be discontinued and a charge will be made to cover the cost of work done.

Item	Description	Fee
	Complete calibration of proving rings, capacity not exceeding 10,000 lb:	
206.044a	Compression ----------	(*)
206.044b	Tension and compression ----------	(*)
	Recalibration of proving rings, capacity not exceeding 10,000 lb:	
206.044c	Compression ----------	(*)
206.044d	Tension and compression ----------	(*)
	Complete calibration of proving rings, capacity exceeding 10,000 lbs but not exceeding 112,000 lb:	
206.044e	Compression ----------	(*)
206.044f	Tension and compression ----------	(*)

[23] NBS Circular 454, Proving Rings for Calibration Testing Machines. In NBS Handbook 77, Precision Measurement and Calibration, Vol. II, Heat and Mechanics, p. 573. (See pp. 133-5 for price information and order form.)

* For current fees, see Change 10 on Insert Sheet 3.

CALIBRATION AND TEST SERVICES OF THE
National Bureau of Standards
Notice of Change to NBS Misc. Publ. 250, 1965 Edition

CHANGE 9. This Insert Sheet and the one preceding contain the revised texts of schedules 201.041 through 201.045. The two sheets should be inserted after p. 102 of MP250, and the old schedule should be deleted.

Item	Description	Fee
	Recalibration of proving rings, capacity exceeding 10,000 lb but not exceeding 112,000 lb:	
206.044g	Compression	(*)
206.044h	Tension and compression	(*)
	Complete calibration of proving rings, capacity exceeding 112,000 lb but not exceeding 300,000 lb:	
206.044i	Compression	(*)
206.044j	Tension and compression	(*)
	Recalibration of proving rings, capacity exceeding 112,000 lb but not exceeding 300,000 lb:	
206.044k	Compression	(*)
206.044l	Tension and compression	(*)
	Complete calibration of proving rings, capacity exceeding 300,000 lb but not exceeding 1,000,000 lb:	
206.044m	Compression	(*)
206.044n	Tension and compression	(*)
	Recalibration of proving rings, capacity exceeding 300,000 lb but not exceeding 1,000,000 lb:	
206.044o	Compression	(*)
206.044p	Tension and compression	(*)
206.044z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the test.	

* For current fees, see Change 10 on Insert Sheet 3.

206.045 Calibration of elastic force measuring devices.

(a) These fees apply to calibration of elastic force measuring devices suitable for use as laboratory or transfer standards.

(b) Before a device is accepted for calibration under this schedule it will be inspected for damage, wear, and operability. Loading surfaces, tension adaptors, and pulling rods must be complete and suitable for use with NBS equipment. The device must be uniquely and permanently marked with the manufacturer's serial number and rated capacity.

(c) For the fee quoted, calibration will be made on one machine with up to 10 different independent loads for compression or tension applied. Devices will be overloaded repeatedly to approximately 10 percent in excess of the manufacturer's rated capacity. A temperature coefficient must be supplied by the submitter of the device.

(d) For each load in excess of 10, an additional fee equal to one-tenth of the applicable fee is charged. For any device requiring the use of more than one machine, a charge will be made covering the cost of additional work involved.

(e) When devices submitted are found to be unsuitable for test or unreliable, a test may be discontinued and a charge will be made to cover the cost of the work done.

Item	Description	Fee
	Capacity not exceeding 10,000 lb:	
206.045a	Compression	(*)
206.045b	Tension	(*)
206.045c	Tension and compression	(*)
	Capacity exceeding 10,000 lb but not exceeding 112,000 lb:	
206.045d	Compression	(*)
206.045e	Tension	(*)
206.045f	Tension and compression	(*)
	Capacity exceeding 112,000 lb but not exceeding 300,000 lb:	
206.045g	Compression	(*)
206.045h	Tension	(*)
206.045i	Tension and compression	(*)
	Capacity exceeding 300,000 lb but not exceeding 1,000,000 lb:	
206.045j	Compression	(*)
206.045k	Tension	(*)
206.045l	Tension and compression	(*)
206.045z	For special tests not covered by the above schedule, fees will be charged dependent upon the nature of the tests.	

* For current fees, see Change 10 on Insert Sheet 3,

CALIBRATION AND TEST SERVICES OF THE National Bureau of Standards

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

CHANGE 11.

Calibration of gamma-, beta-, and alpha-emitting radioactive samples: The text of schedules 204.201, 204.202, and 204.203, which appears on pp. 93 to 95 of MP250, is replaced by the revised text given below. Minor changes of phraseology have been made in several places; cerium–139 and cerium–141 have been added to the materials listed in 204.201b(iii); and strontium–89 has been added to the materials listed in 204.203b(ii). The fees have been generally revised upwards to yield full recovery of the cost of providing the services. The old fees, given on p. 128 of MP250, should be crossed out and the new ones written beside them.

204.201 Calibration of gamma-emitting radioactive samples

Calibration of gamma-emitting radioactive samples that conform to the physical, chemical, and activity level specifications for measurement in the National Bureau of Standards calibrated $4\pi\gamma$ ionization chamber.

ITEM	DESCRIPTION	FEE
204.201a	(1) 100-300 micrograms radium	$110.00
	(2) Chemically stable solutions of the following radionuclides in the specified activity ranges can be measured	$110.00
	i. 50-100 microcuries sodium–22, sodium–24, scandium–46, cobalt–60, yttrium–88.	
	ii. 150-300 microcuries manganese–54, iron–59, zinc–65, strontium–85, niobium–95, iodine–131, cesium–137, tantalum–182, gold–198, mercury–203.	
	iii. 300-600 microcuries potassium–42, cobalt–57, cerium–139, cerium–141.	
	Solutions should be 5 ml in volume and flame-sealed in glass vials or ampoules of O.D. 16.0 $\pm$0.5 mm, wall thickness approximately 0.5 mm.	
204.201b	Chemically stable solutions of the following radionuclides in the specified activity ranges can be measured	$135.00
	i. 10-20 microcuries sodium–22, sodium–24, scandium–46, cobalt–60, yttrium–88.	

* Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of insert sheet are available from NBS Office of Technical Information and Publications.

ITEM	DESCRIPTION	FEE
	ii. 30-60 microcuries manganese–54, iron–59, zinc–65, strontium–85, niobium–95, iodine–131, cesium–137, tantalum 182, gold–198, mercury–203. iii. 60-100 microcuries potassium–42, cobalt–57, cerium–139, cerium–141. Solutions should be 5 ml in volume and flame-sealed in glass vials or ampoules of O.D. 16.0 $\pm$0.5 mm, wall thickness approximately 0.5 mm.	
204.201z	For tests not covered by the above schedule, fees will be charged dependent on the time involved in making the tests.	

204.202 Calibration of alpha-emission rate of sources.

Calibration of alpha-emitting radioactive samples that conform to the physical and activity level specifications for measurement in the National Bureau of Standards $2\pi\alpha$ proportional counter.

ITEM	DESCRIPTION	FEE
204.202a	Chemically stable samples that conform to the physical and activity level specifications listed below can be measured _____ i. Source diameter should not exceed 10 cm. ii. Source thickness should be such that more than 99.5% of the emitted alpha particles have an energy greater than 400 keV. iii. Emission rate should not exceed $5x10^3$ αps.	$ 88.00
204.202z	For tests not covered by the above schedule, fees will be charged dependent on time involved in making the tests.	

204.203 Calibration of beta-emitting radioactive samples.

Calibration of beta-emitting radioactive samples that conform to the physical, chemical, and activity level specifications for measurement in either the National Bureau of Standards calibrated $2\pi\beta$ windowless proportional flow counter, or in the National Bureau of Standards calibrated $2\pi\beta$ ionization chamber.

ITEM	DESCRIPTION	FEE
204.203a	Chemically stable solutions of the following radionuclides in the specified activity ranges can be measured in the National Bureau of Standards calibrated $2\pi\beta$ windowless proportional flow counter ___ i. 1-10 microcuries/milliliter chlorine–36, strontium-yttrium–90. ii. 2-20 microcuries/milliliter thallium–204. iii. 5-50 microcuries/milliliter calcium–45, promethium–147. iv. 10-100 microcuries/milliliter sulfur–35. Solutions should be approximately 5 ml in volume and flame-sealed in glass vials or ampoules.	$285.00
204.203b	Chemically stable solutions of the following radionuclides in the specified activity ranges can be measured in the National Bureau of Standards calibrated $2\pi\beta$ ionization chamber _____ i. 2-20 microcuries/milliliter phosphorus–32. Solution should be neutral or weak acid with not more than 0.2 mg/ml total solids. ii. 2-20 microcuries/milliliter strontium–89, strontium-yttrium–90. Solution should be weak HCl (1N or less) with not more than 0.2 mg/ml total solids. Solutions should be approximately 5 ml in volume and flame-sealed in glass vials or ampoules.	$150.00
204.203z	For tests not covered by the above schedule, fees will be charged dependent on the time involved in making the tests.	

CHANGE 12.

Working standards of length: As a result of new calibration instrumentation, the fee for item 204.402c (relating to the calibration of submultiples of length intervals) is reduced to $3.00. The old fee of $33.00 for item 204.402c, listed on p. 127 of MP250, should be deleted. The text of the item, on p. 65 of MP250, remains unchanged.

CALIBRATION AND TEST SERVICES OF THE
National Bureau of Standards
Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

CHANGE 13.

Calibration and measurement services of the NBS Radio Standards Laboratory, Boulder, Colorado: The schedules of services performed by the Radio Standards Laboratory, covered in Section 201.701 through 201.950, have been generally extended and revised as shown in detail below. Additional services are listed in Sections 201.812, 201.830, 201.861, 201.912, and 201.940, and changes in wording and arrangement have been made at various places to improve clarity. The new schedules, which follow, replace the old ones which appear on pp. 34-49 of MP250; the latter should be deleted.

The schedules covered by this Insert are the following:

Low-Frequency Region

201.701 Frequency stability of signal sources, to 30 kHz

High-Frequency Region

201.800 General

201.810 Rf, rf-d-c voltmeters, and thermal converters in the frequency range of 30 kHz to 1000 MHz, from 0.1 to 300 V

201.811 Rf micropotentiometers, voltmeters, and signal sources in the frequency range of 30 kHz to 1000 MHz, from 1 μV to 0.1 V

201.812 Pulse voltage, peak measurement, coaxial systems

201.820 Rf calorimeters, 30 kHz to 500 MHz

201.821 Coaxial bolometer units and bolometer-coupler units, continuous wave, low-level power

201.822 Pulse power, peak measurement, coaxial systems

201.830 Immittance, two-terminal devices, 30 kHz to 8 GHz

201.831 Immittance, three-terminal devices, 100 kHz to 1 MHz

201.840 Dissipative fixed coaxial attenuators

201.841 Dissipative variable coaxial attenuators

201.842 Waveguide below-cutoff (piston) attenuators

201.843 Coaxial fixed directional couplers

201.844 Coaxial variable directional couplers

* Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of insert sheet are available from NBS Office of Technical Information and Publications.

201.850 Electric and magnetic field strength measurements

201.851 Field-strength receivers (0 to 1000 MHz)

201.852 Loop antennas (30 Hz to 30 MHz)

201.853 Dipole antennas (30 to 1000 MHz)

201.860 Frequency stability of signal sources, 30 kHz to 500 MHz

201.861 Power spectral analysis of signal sources

Microwave Region

201.900 General

201.910 Waveguide bolometer units and bolometer-coupler units, continuous wave, low-level power

201.911 Waveguide dry calorimeters, continuous wave, low-level power

201.912 Coaxial bolometer units, continuous wave, low-level power

201.920 Waveguide reflectors (mismatches), reflection coefficient magnitude

201.930 Cavity wavemeters, frequency measurement

201.940 Waveguide variable attenuators, attenuation difference

201.941 Waveguide fixed attenuators, insertion loss

201.950 Waveguide noise sources, effective noise temperature

Low-Frequency Region

201.701 Frequency stability of signal sources, to 30 kHz.

(Services available only at the NBS Radio Standards Laboratory, Boulder, Colorado.)

(a) Frequency stability calibrations are made on signal sources up to 30 kHz. (See Section 201.860 for calibration service at higher frequencies.)

(b) The signal source should have a power output of at least 10 mW (into a matched load).

(c) Frequency stability of the signal source should be better than approximately one part in 10^7.

ITEM	DESCRIPTION	FEE
201.701a	Measurement of frequency stability of signal sources, up to 30 kHz	(*)
201.701z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

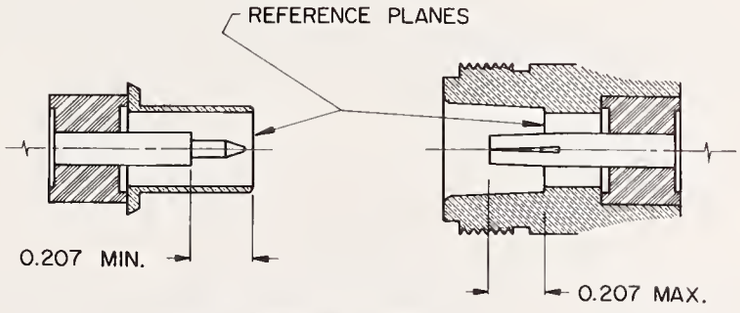
High-Frequency Region

201.800 General.

The "High-Frequency Region" for purposes of this schedule, extends approximately from 30 kHz to 18 GHz. As the "Microwave Region" starts at approximately 1 GHz, the two regions overlap in that portion of the spectrum between 1 GHz and 18 GHz. The present coverage in the "High-Frequency Region" above 1 GHz is quite limited and involves only coaxial structures. It should be noted that some calibration services for coaxial instruments are listed in the "Microwave Region" sections of this schedule in addition to the waveguide services listed therein.

In the "High-Frequency Region" the Radio Standards Laboratory, Boulder, Colorado, is equipped to calibrate standards of pulse and CW voltage, pulse and CW power, immittance, attenuation, and field strength. Calibrations are performed at discrete frequencies as well as continuously over certain frequency bands (depending upon the particular item).

Connectors limit the accuracy of measurements in the high-frequency region to some extent, particularly at the higher frequencies. To avoid uncertainty from this cause, all interlaboratory standards submitted for calibration, fitted with coaxial connectors, should be equipped with Type N connectors complying with the MIL C 39012/1, 2 specification, or with the new precision 7 or 14 mm connectors. The critical mating dimensions required by NBS for Type N connectors are shown in the following diagram.



201.810 Rf, rf–d-c voltmeters, and thermal converters in the frequency range of 30 kHz to 1000 MHz, from 0.1 to 3000 V.

Ordinarily instruments equally suitable for use on dc and rf will be calibrated only for rf–d-c difference by the procedure of Item 201.810a, since periodic calibrations can be made by the user on reversed direct current. Such reversed d-c calibrations will be made only under unusual circumstances and by advance arrangement. Instruments suitable for use only on rf will be given rf calibrations by the procedures of Items 201.810a, b, c, d. Instruments which respond to average or peak values or which are not in ASA accuracy class one-quarter percent or better are not usually accepted for calibration below 30 MHz.

ITEM	DESCRIPTION	FEE
201.810a	Measurement of a voltage or an rf–d-c difference at 30, 100, 300 kHz, 1, 3, 10, 30, or 100 MHz in the range of 0.1 to 300 V	(*)
201.810b	Each measurement additional to 201.810a at a different frequency or voltage	(*)
201.810c	Measurement of a voltage at 300, 400, 500, 700, or 1000 MHz, in the range of 0.2 to 20 V	(*)
201.810d	Each measurement additional to 201.810c at a different frequency or voltage	(*)
201.810z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.811 RF micropotentiometers, voltmeters, and signal sources in the frequency range of 30 kHz to 1000 MHz, from 1μV to 0.1 V.

Only high-quality voltmeters, suitable for use as interlaboratory standards, are normally accepted for calibration. These instruments should have a stability of one percent or better and an accuracy of three percent or better. Rf voltmeters will be calibrated by the procedures of Items 201.811a, b, c, d.

Only signal sources high enough in quality to be considered as interlaboratory standards are accepted for calibration. If these instruments are equally suitable for use on dc and rf, they will be calibrated for rf-dc difference by the procedures of Items 201.811a, b, c, d. Signal sources suitable for use only on rf will be calibrated by the procedures of Items 201.811a, b.

ITEM	DESCRIPTION	FEE
201.811a	Measurement of a voltage for micropotentiometers, voltmeters, and signal sources in the range of 50 kHz to 900 MHz, from 1 μV to 0.1 V	(*)
201.811b	Each measurement additional to 201.811a at a different frequency or voltage	(*)
201.811c	Measurement of a voltage for voltmeters in the range of 900 to 1000 MHz, from 100 μV to 0.1 V	(*)
201.811d	Each measurement additional to 201.811c at a different frequency or voltage	(*)
201.811z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.812—Pulse voltage, peak measurement, coaxial systems.

(a) For general information on pulse terminology reference is made to the following: "Standards on Pulses: Definition of Terms—Part I, 1951," Proc. IRE, Vol. 39, No. 6, June 1951.

"Standards on Pulses: Definition of Terms—Part II, 1952," Proc. IRE, Vol. 40, No. 5, May 1952.

Specifically, in this schedule, the term "peak duration for a trapezoidal pulse" denotes the time interval between the leading edge and trailing edge at 99.8 percent of maximum pulse amplitude.

"Pulse duration for a trapexoidal pulse" denotes the time interval between the leading edge and trailing edge at 50 percent of maximum pulse amplitude.

(b) Measurements are made with unidirectional, trapezoidal pulses with a rise and fall time of 10 nanoseconds or greater and with a peak duration of 10 nsec or greater for pulse amplitudes less than 100 V.

(c) For amplitudes greater than 100 V, the pulses have a rise and fall time of 30 nsec or greater and a peak duration of 30 nsec or greater.

ITEM	DESCRIPTION	FEE
201.812a	Calibration of instrument for peak voltage measurement of pulse waveforms in coaxial systems in the voltage range of 5 to 100 V; pulse duration 20 nsec to 100 μsec; pulse repetition rate 60 to 2×10^6 pps, with a maximum duty cycle of 0.1	(*)
201.812b	Calibration of each additional instrument for peak voltage measurement, performed under conditions of 201.812a	(*)
201.812c	Calibration of instrument for peak voltage measurement of pulse waveforms in coaxial systems in the voltage range of 100 to 1000 V; pulse duration 60 nsec to 5 μsec; pulse repetition rate, 60 to 1.66×10^5 pps, with a maximum duty cycle of 0.01	(*)
201.812d	Calibration of each additional instrument for peak voltage measurement, performed under conditions of 201.812c	(*)
201.812z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.820 RF calorimeters, 30 kHz to 500 MHz.

(a) For maximum calibration accuracy, interlaboratory rf calorimeters should repeat readings to one-half percent or better with a constant power input.

(b) At present only rf calorimeters utilizing Type N or precision connectors for rf power input can be calibrated. Refer to 201.800 for special requirements for the connectors used on interlaboratory standards.

ITEM	DESCRIPTION	FEE
201.820a	Measurement of rf calorimeter at one frequency at 100 or 300 kHz, 1, 3, 10, or 30 MHz; and at one power level, from 0.001 to 200 W__	(*)
201.820b	Measurement of each additional power level at the same frequency as for 201.820a _____	(*)
201.820c	Measurement of rf calorimeter at one frequency at 100, 200, 300, 400, or 500 MHz; at one power level, from 0.001 to 100 W _____	(*)
201.820d	Measurement of each additional power level at the same frequency as for 201.820c _____	(*)
201.820z	Special calibrations not covered by the above schedule _____	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.821 Coaxial bolometer units and bolometer-coupler units, continuous wave, low-level power.

(a) A bolometer unit includes both the bolometer element or elements and the bolometer mount in which they are supported.

(b) Power measurements are made on barretter-type bolometer units having nominal resistance of 50, 100, or 200 ohms at a bias current between 3.5 and 10 mA; and on thermistor-type bolometer units having a nominal resistance of 50, 100, or 200 ohms at a bias current between 5 and 15 mA. Bolometer units should be of the fixed tuned or untuned broadband type and must have suitable[13] male or female Type N or precision connectors.

(c) Power measurements are made on bolometer units at cw power levels of 1 and 10 mW only.

(d) Power measurements are made on bolometer-coupler combinations having coupling ratios from 3 to 30 dB. A bolometer unit of the fixed tuned or untuned broadband type should be permanently attached to the side arm of the directional coupler. The directional coupler should have good design features, with a directivity of 30 dB or greater, and a VSWR no greater than 1.10 for the input and output ports of the main arm of the coupler.

(e) Effective efficiency for bolometer units is defined as the ratio of the substituted dc power in the bolometer unit to the power dissipated within the bolometer unit[14].

(f) Calibration factor for bolometer units is defined as the ratio of the substituted dc power in the bolometer unit to the rf power incident upon the bolometer unit[14].

(g) Calibration factor for bolometer-coupler units is defined as the ratio of the substituted dc power in the bolometer unit on the side arm of the directional coupler to the rf power incident upon a 50-ohm load (with a VSWR less than 1.05) attached to the output port of the main arm[14].

[13] See Section 201.800

[14] Desch, R. F., and R. E. Larson, Bolometric microwave power calibration techniques at NBS, IEEE Trans. Instr. Meas. IM–12, No. 1, 29 (June 1963).

ITEM	DESCRIPTION	FEE
201.821a	Determination of calibration factor of coaxial bolometer unit at one frequency at 100 MHz or 1 GHz; and at one power level, 1 or 10 mW	(*)
201.821b	Determination at each additional power level at the same frequency as for 201.821a	(*)
201.821c	Determination of calibration factor of coaxial bolometer unit at 3** GHz; and at one power level, 1 or 10 mW	(*)
201.821d	Determination at each additional power level at 3** GHz, as for 201.821c	(*)
201.821e	Determination of calibration factor of coaxial bolometer-coupler unit at one frequency at 30, 100, 200, 300, 400, 500 MHz, or 1 GHz; and at one power level	(*)
201.821f	Determination at each additional power level at the same frequency as for 201.821e	(*)
201.821z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

** For measurements on coaxial bolometer units at 4 GHz and higher frequencies, see 201.912.

201.822 Pulse power, peak measurement, coaxial systems.

(a) Instruments submitted for calibration should have a nominal impedance of 50 ohms, and be fitted with Type N, BNC, HN, or precision input connectors.[13]

(b) Measurements are made with pulsed rf signals having a rectangular envelope.

ITEM	DESCRIPTION	FEE
201.822a	Calibration of instrument for measuring peak power of pulsed signals in coaxial systems, in the frequency range of 950 to 1200 MHz, at a peak power in the range of 1 mW to 3 kW; at a pulse width in the range of 2 to 10 μsec, and at a pulse repetition rate in the range of 100 to 1600 pps with a maximum duty cycle of 0.0033	(*)
201.822b	Calibration of instrument for measuring peak power of pulsed signals in coaxial systems at each additional peak power level or a different pulse width or pulse repetition rate, at the same frequency as for 201.822a	(*)
201.822z	Special calibrations not covered by the above schedule	(*)

[13] See Section 201.800

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.830 Immittance, two-terminal devices, 30 kHz to 8 GHz.

(a) Maximum accuracy can be achieved only in the case of instruments and components equipped with connectors having a plane of reference directly compatible with the NBS system with no necessity for special adapters. In the interest of preserving higher calibration accuracies, coaxial connectors should be utilized on standard instruments and components wherever possible. Calibrations are not performed on capacitors with unshielded terminals; e.g., binding posts and banana-plug connectors.

(b) Power applied to any item under test will normally not exceed 1 W. Where caution in this respect is necessary it should be clearly stated in the calibration request. All calibrations described in this section are performed under ambient conditions of 23 ±2 degrees C and 40 ±2 percent relative humidity.

ITEM	DESCRIPTION	FEE
201.830a–1	Two-terminal impedance measurement at one point in the frequency range 30 to 400 kHz, 0 to 10,000 ohms resistance, and 0 to 1100 μH inductance	(*)
201.830a–2	Two-terminal impedance measurement at each additional point within limits of 201.830a–1	(*)
201.830b–1	Two-terminal impedance measurement at one point in the frequency range 30 kHz to 1 MHz, 0 to 1000 ohms resistance, and 0 to 110 μH inductance	(*)
201.830b–2	Two-terminal impedance measurement at each additional point within limits of 201.830b–1	(*)
201.830c–1	Two-terminal admittance measurement at one point in the frequency range 30 kHz to 1 MHz, 0 to 110 μmhos conductance, and 0 to 1100 pF capacitance	(*)
201.830c–2	Two-terminal admittance measurement at each additional point within limits of 201.830c–1	(*)
201.830d–1	Two-terminal admittance measurement at one point in the frequency range 5 to 300 MHz, 0 to 50 mmhos conductance, and 0 to 50 pF capacitance	(*)
201.830d–2	Two-terminal admittance measurement at each additional point within limits of 201.830d–1	(*)
201.830e–1	Q-Standard measurement in the frequency range 50 kHZ to 45 MHz, 0 to 1000 for effective Q, and 30 to 450 pF for effective resonating capacitance	(*)
201.830f–1	Two-terminal impedance measurement of coaxial component at one point in frequency range 50 MHz to 8 GHz, within range of 0.5 to 5000 ohms for magnitude and 0 to 90° for phase angle	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

ITEM	DESCRIPTION	FEE
201.830g–1	Measurement of magnitude of reflection coefficient of a coaxial matched termination in 50-ohm line at one point in frequency range 1 to 4 GHz, by coaxial reflectometer to provide greater accuracy than provided by 201.830f–1	(*)
201.830g–2	Each additional point within limits of 201.830g–1	(*)
201.830z	Special two-terminal immittance measurements not covered by the above	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.831 Immitance, three-terminal devices, 100 kHz to 1 MHz.

(a) Three-terminal techniques are required for the measurement of extremely low admittance so that unwanted admittance to ground (especially capacitances) do not significantly affect the measurements. Conductance or dissipation factor is not included in Reports of Calibration for three-terminal capacitance.

(b) All measurements described in this section are performed under ambient conditions of 23 ±2 degrees C and 40 ±2 percent relative humidity.

ITEM	DESCRIPTION	FEE
201.831a–1	Three-terminal capacitance measurement at 100 kHz, 465 kHz, or 1 MHz for fixed nominal values of 10^{-2}, 10^{-1}, 10^{0}, 10^{1}, 10^{2}, and 10^{3} pF, per frequency	(*)
201.831b–1	Three-terminal capacitance measurement at 465 kHz at one point in the range 0.001 to 100 pF	(*)
201.831b–2	Three-terminal capacitance measurement at 465 kHz at each additional point within limits of 201.831b–1	(*)
201.831z	Special three-terminal immitance measurements not covered by above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.840 Dissipative fixed coaxial attenuators.

(a) Dissipative fixed coaxial attenuators are normally calibrated in a system having a characteristic impedance of 50 ohms. Since the accuracy of the calibration is degraded by any deviation or uncertainty in this characteristic impedance, the types of allowable connectors are limited. Connectors having a known plane of reference, or the Type N or precision connectors[13] are required. All measurements are made by the substitution

[13] See Section 201.800

method, which requires that the connectors used be asexual or the attenuator have a male connector at one port and a female connector at the other port. If an adapter is required to comply with the foregoing, it must be supplied with the attenuator and the combination will be calibrated as one unit.

(b) Maximum power to any attenuator will not exceed 20 mW unless prior arrangements for higher power levels have been made.

(c) Insertion loss is defined as the loss encountered when a standard connector[15] pair is broken and the attenuator under test is inserted. The parameters of the standard connector pair must be known, and the generator and load impedances have been adjusted so that the system is non-reflecting. These conditions cannot be strictly realized and an allowance for mismatch must be made.

ITEM	DESCRIPTION	FEE
201.840a–1	Measurement of insertion loss of coaxial attenuator at one of the following frequencies: 1, 10, 60, and 100 MHz, in the range of 0 to 80 dB	(*)
201.840a–2	Measurement of insertion loss of fixed coaxial attenuator at a frequency of 30 MHz, in the range of 0 to 100 dB	(*)
201.840a–3	Measurement of insertion loss of each additional fixed coaxial attenuator at the same frequency and over the same ranges as for 201.840a–1 to 201.840a–2	(*)
201.840b–1	Measurement of insertion loss of fixed coaxial attenuator at any frequency from 0.100 to 8.19 GHz in the range of 0 to 60 dB (†)	(*)
201.840b–2	Measurement of insertion loss of fixed coaxial attenuator at any frequency from 8.2 to 12.39 GHz, in the range of 0 to 60 dB (†)	(*)
201.840b–3	Measurement of insertion loss of fixed coaxial attenuator at any frequency from 12.4 to 18.0 GHz, in the range of 0 to 60 dB (†)	(*)
201.840b–4	Measurement of insertion loss of each additional fixed coaxial attenuator at the same frequency and over the same ranges as for 201.840b–1 to 201.840b–3	(*)
201.840z	Special calibrations not covered by the above schedule	(*)

(†) Measurement of insertion loss available to 80 dB at reduced accuracy.

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.841 Dissipative variable coaxial attenuators.

(a) These attenuators are calibrated in acordance with Item 201.840 except that the zero or other specified setting is used as the reference. Because attenuation difference only is measured, both ports may have the same connector.

[15] Beatty, Roberts W., Effects of connectors and adapters on accurate attenuation measurements at microwave frequencies, IEEE Trans. Instr. Meas. IM–13, No. 4, 272 (Dec. 1964). In this referenced publication a "standard connector" is defined as one which is made precisely to standard specifications for the particular type of connector under consideration. Standard connector pairs usually have low but appreciable loss and reflection.

(b) Variable attenuators must have a repeatability of setting better than 0.1 dB; incremental attenuators must have a repeatability of 0.01 dB or better.

ITEM	DESCRIPTION	FEE
201.841a–1	Measurement of one increment on a dissipative variable attenuator at one of the following frequencies: 1, 10, 60, and 100 MHz, in the range of 0 to 80 dB	(*)
201.841a–2	Measurement of one increment on a dissipative variable attenuator at a frequency of 30 MHz, in the range of 0 to 100 dB	(*)
201.841a–3	Measurement of each additional increment on a dissipative variable attenuator at the same frequency and over the same ranges as for 201.841a–1 to 201.841a–2	(*)
201.841b–1	Measurement of one increment on a dissipative variable attenuator at any frequency from 0.100 to 8.19 GHz, in the range of 0 to 60 dB	(*)
201.841b–2	Measurement of one increment on a dissipative variable attenuator at any frequency from 8.2 to 12.39 GHz, in the range of 0 to 60 dB	(*)
201.841b–3	Measurement of one increment on a dissipative variable attenuator at any frequency from 12.4 to 18.0 GHz, in the range of 0 to 60 dB	(*)
201.841b–4	Measurement of each additional increment on a dissipative variable attenuator at same frequency and over the same ranges as for 201.841b–1 to 201.841b–3	(*)
201.841z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.842 Waveguide below-cutoff (piston) attenuators.

(a) Waveguide below-cutoff attenuators are calibrated normally in a system having a characteristic impedance of 50 ohms. As only attenuation difference measurements are made on this type of attenuator, Type BNC, C, TNC connectors and other types are acceptable but precision connectors are preferred.

(b) An insertion loss measurement at the attenuator zero setting can be made. Maximum power to any attenuator will not exceed 20 mW unless prior arrangements for higher power levels have been made.

(c) Calibrations are performed at the following frequencies: 1, 10, 30, 60, and 100 MHz.

ITEM	DESCRIPTION	FEE
201.842a–1	Measurement of one increment on a waveguide below-cutoff attenuator at one of the following frequencies: 1, 10, 60, and 100 MHz, in the attenuation range (including initial insertion loss) of 0 to 120 dB	(*)
201.842a–2	Measurement of one increment on a waveguide below-cutoff attenuator at 30 MHz, in the attenuation range (including initial insertion loss) of 0 to 140 dB	(*)
201.842a–3	Measurement of each additional increment on a waveguide below-cutoff attenuator at the same frequency and over the same ranges as for 201.842a–1 to 201.842a–2	(*)
201.842z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.843 Coaxial fixed directional couplers.

Coaxial fixed directional couplers are calibrated in accordance with Item 201.840. Terminations must be supplied for any arm not used during a measurement.

ITEM	DESCRIPTION	FEE
201.843a–1	Measurement of insertion loss between any two ports of a coaxial fixed directional coupler at any one of the following frequencies: 1, 10, 60, and 100 MHz, in the range of 0 to 80 dB	(*)
201.843a–2	Measurement of insertion loss between any two ports of a coaxial fixed directional coupler at a frequency of 30 MHz, in the range of 0 to 100 dB	(*)
201.843a–3	Each additional measurement of insertion loss between any two ports of a coaxial fixed directional coupler at same frequency and over the same range as for 201.843a–1 to 201.843a–2	(*)
201.843b–1	Measurement of insertion loss between any two ports of a coaxial fixed directional coupler at any frequency from 0.100 to 8.19 GHz, in the range of 0 to 60 dB	(*)
201.843b–2	Measurement of insertion loss between any two ports of a coaxial fixed directional coupler at any frequency from 8.2 to 12.39 GHz, in the range of 0 to 60 dB	(*)
201.843b–3	Measurement of insertion loss between any two ports of a coaxial fixed directional coupler at any frequency from 12.4 to 18.0 GHz, in the range of 0 to 60 dB	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

ITEM	DESCRIPTION	FEE
201.843b–4	Each additional measurement of insertion loss between same two ports of a coaxial fixed directional coupler, and at the same frequency, and over the same range as for 201.843b–1 to 201.843b–3	(*)
201.843z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.844 Coaxial variable directional couplers.

(a) Coaxial variable directional couplers are calibrated in accordance with Item 201.-841. Terminations must be supplied for any arm not used during a measurement.

(b) The change in coupling to the sidearm relative to the minimum setting on the device is normally measured.

ITEM	DESCRIPTION	FEE
201.844a–1	Measurement of single coupling increment between input and variable arm of coaxial variable directional coupler at one of the following frequencies: 1, 10, 60, and 100 MHz, in the range (including initial coupling loss) of 0 to 80 dB	(*)
201.844a–2	Measurement of single coupling increment between input and variable arm of coaxial variable directional coupler at a frequency of 30 MHz, in the range of 0 to 100 dB	(*)
201.844a–3	Each additional measurement of coupling increment between input and variable arm of coaxial variable directional coupler at same frequency and over the same ranges as for 201.844a–1 to 201.844a–2	(*)
201.844b–1	Measurement of single coupling increment between input and variable arm of coaxial variable directional coupler at any frequency from 0.100 to 8.19 GHz, in the range of 0 to 60 dB (including initial coupling loss)	(*)
201.844b–2	Measurement of single coupling increment between input and variable arm of coaxial variable directional coupler at any frequency from 8.2 to 12.39 GHz, in the range of 0 to 60 dB (including initial coupling loss)	(*)
20.844b–3	Measurement of single coupling increment between input and variable arm of coaxial variable directional coupler at any frequency from 12.4 to 18.0 GHz, in the range of 0 to 60 dB (including initial coupling loss)	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

ITEM	DESCRIPTION	FEE
201.844b–4	Each additional measurement of coupling increment between input and variable arm of coaxial variable directional coupler at the same frequency and over the same ranges as for 201.844b–1 to 201.844b–3	(*)
201.844z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.850 Electric and magnetic field strength measurements.

Field-strength standards and field-strength meters are calibrated in terms of rms cw signals in the frequency range of 30 Hz to 1000 MHz. Loop antennas are calibrated from 30 Hz to 30 MHz, and horizontally-polarized dipole antennas are calibrated from 30 to 1000 MHz. The antennas of field-strength meters are calibrated normally when terminated in their respective field-strength receivers. The field-strength receivers are calibrated normally for use in a 50-ohm system.

When field-strength standards or meters are submitted for calibration an instruction manual and all accessories should be included, and the instrument must be in excellent operating condition.

201.851 Field-strength receivers (0 to 1000 MHz).

There are three basic calibrations that can be performed on a field-strength receiver:

1. Calibration of the receiver as a two-terminal rf voltmeter.
2. Calibration of the signal input attenuators.
3. Determination of overall linearity of the receiver in terms of the output indicating circuits.

ITEM	DESCRIPTION	FEE
201.851a–1	Calibration of receiver as a two-terminal rf voltmeter, 1 to 10,000 μV, 0 to 1000 MHz, at one frequency	(*)
201.851a–2	Calibration of receiver as a two-terminal rf voltmeter at each frequency additional to Item 201.851a–1, 0 to 400 MHz	(*)
201.851a–3	Calibration of receiver as a two-terminal rf voltmeter at each frequency additional to Item 201.851–a, 400 to 1000 MHz	(*)
201.851b–1	Calibration of initial step of the input attenuator at one frequency, 0 to 1000 MHz	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

ITEM	DESCRIPTION	FEE
201.851b–2	Calibration of each additional step of the input attenuator, additional to Item 201.851b–1, 0 to 1000 MHz	(*)
201.851c–1	Determination of overall linearity of receiver and output circuit, at one frequency and one attenuator setting, initial point, 0 to 1000 MHz	(*)
201.851c–2	Determination of overall linearity at each additional point, at same frequency and at same attenuator setting as for 201.851c–1	(*)
201.851z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.852 Loop antennas (30 Hz to 30 MHz).

Loop antennas are calibrated in terms of a quasi-static magnetic field at frequencies from 30 Hz to 30 MHz. The magnitude of the calibrating field varies from approximately 20 to 200 mV/m.

ITEM	DESCRIPTION	FEE
201.852a	Calibration of loop antenna at one frequency, 30 Hz to 30 MHz	(*)
201.852b	Calibration of loop antenna at each frequency additional to Item 201.852a, 30 Hz to 30 MHz	(*)
201.852z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.853 Dipole antennas (30 to 1000 MHz).

Dipole antennas are calibrated in terms of horizontally-polarized fields at frequencies from 30 to 1000 MHz. The magnitude of the calibrating field varies from approximately 20 to 400 mV/m.

ITEM	DESCRIPTION	FEE
201.853a	Calibration of dipole antenna at one frequency, 30 to 400 MHz	(*)
201.853b	Calibration of dipole antenna at one frequency, 400 to 1000 MHz	(*)
201.853c	Calibration of dipole antenna at each frequency additional to Items 201.853a and 201.853b, 30 to 1000 MHz	(*)
201.853z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.860 Frequency stability of signal sources, 30 kHz to 500 MHz.

(a) Frequency stability calibrations are made on signal sources from 30 kHz to 500 MHz. (See Schedule 201.701 for calibration service at lower frequencies.)

(b) The signal source should have a power output of at least 10 mW (into a matched load).

(c) Frequency stability of the signal source should be better than approximately one part in 10^7.

ITEM	DESCRIPTION	FEE
201.860a	Measurement of frequency stability of precision fixed-frequency signal source in the frequency range of 30 kHz to 500 MHz_____	(*)
201.860z	Special calibrations not covered by the above schedule _____	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.861 Power spectral analysis of signal sources.

(a) Power spectral analysis of frequency-modulation components of frequency standards and other high-quality signal sources are made at nominal frequencies of 1, 2.5, 5, and 10 MHz.

(b) Frequency-modulation components are measured to limits of ± 10 kHz from the carrier frequency for magnitudes greater than 6 dB above the continuous noise spectrum.

(c) Noise power level of the continuous spectrum relative to the power level of the carrier frequency is measured at any selected frequency within ±10 kHz of the carrier frequency.

(d) The signal source should have a power output of at least 20 mW (into a matched load).

ITEM	DESCRIPTION	FEE
201.861a	Measurement of the power spectrum of a fixed signal source _____	(*)
201.861z	Special calibrations not covered by the above schedule _____	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

Microwave Region

201.900 General

(a) Microwave calibration services presently available include measurements of power, impedance, frequency, attenuation, and noise. The frequency range covered for each of the waveguide measurements is given below. While most of the calibration services are for waveguide, it should be noted there are a few services listed in the "Microwave Re-

gion" for coaxial instruments. Additional services in the 1 GHz to 18 GHz range for coaxial instruments are listed in the "High-Frequency Region" sections of this schedule.

(b) In performing microwave calibrations, a considerable amount of time is needed to prepare the system for measurement operation. Much of this preparation is related to the adjustment of the system to the frequency of operation selected for the calibration. Time and cost often can be reduced by minimizing the number of times the operating frequency of the calibration system must be readjusted. To help in achieving this reduction in costs, a list of suggested calibration frequencies is presented in the following table. These frequencies are suggested for use in connection with this schedule and for interlaboratory standards utilizing terminations consisting of the standard waveguide sizes given below in the table of suggested calibration frequencies. It should be emphasized that the suggested frequencies are primarily for economy and for convenience to those requesting calibrations. In general the calibration instrumentation for the microwave region is intended to provide complete and continuous frequency coverage as appropriate for the various waveguide sizes. Those having need for calibrations at other than suggested frequencies can be accommodated.

EIA waveguide designation	Frequency range, GHz	Suggested calibration frequencies GHz		
		No. 1	No. 2	No. 3
WR430	1.70– 2.60	1.80	2.20	2.50
WR284	2.60– 3.95	2.85	3.25	3.55
WR187	3.95– 5.85	4.35	4.90	5.25
WR137	5.85– 8.20	6.45	7.00	7.40
WR112	7.05–10.0	7.75	8.50	9.00
WR90	8.20–12.4	9.00	9.80	11.2
WR62	12.4 –18.0	13.5	15.0	17.0
WR42	18.0 –26.5	19.8	22.0	23.8
WR28	26.5 –40.0	29.0	33.0	37.0

201.910 Waveguide bolometer units and bolometer-coupler units, continuous wave, low-level power.

(a) Power measurements are made on barretter-type bolometer units having nominal resistance of either 100 or 200 ohms at a bias current between 3.5 and 10 mA, and on thermistor-type bolometer units having a nominal resistance of either 100 or 200 ohms at a bias current between 5 and 15 mA. Bolometer units should be of the fixed tuned or untuned broadband type.

(b) Power measurements are made on waveguide bolometer units at power levels from 0.1 to 10 mW.

(c) Power measurements are made on bolometer-coupler combinations having coupling ratios from 3 to 20 dB. A bolometer unit of the fixed tuned or untuned broadband type should be permanently attached to the side arm of the coupler. The three-port directional coupler should have good design features, with a directivity of 40 dB or greater and a VSWR no greater than 1.05 for the input and output ports of the main arm of the coupler.

(d) Efficiency for bolometer units is defined as the ratio of the microwave power absorbed by the barretter element to the microwave power dissipated within the bolometer unit.[14]

(e) Calibration factor for bolometer units is defined as the ratio of the substituted dc power in the bolometer unit to the microwave power incident upon the bolometer unit.[14]

(f) Calibration factor for bolometer-coupler units is defined as the ratio of the substituted dc power in the bolometer unit on the side arm of the directional coupler to the microwave power incident upon a nonreflecting load attached to the output port of the main arm.[14]

(g) Effective efficiency for bolometer units is defined as the ratio of the substituted dc power in the bolometer unit to the microwave power dissipated within the bolometer unit.[14]

ITEM	DESCRIPTION	FEE
	Determination of effective efficiency of bolometer unit at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.910a–1	WR90 (8.20–12.4 GHz)	(*)
201.910a–2	WR62 (12.4–18.0 GHz)	(*)
201.910a–3	WR137 (5.85–8.20 GHz)	(*)
201.910a–4	WR112 (7.05–10.0 GHz)	(*)
201.910a–5	WR187 (3.95–5.85 GHz)	(*)
201.910a–20	Determination of effective efficiency of each additional bolometer unit at the same frequency as for 201.910a–1	(*)
201.910a–21	Determination of effective efficiency of each additional bolometer unit at the same frequency as for 201.910a–2 to 201.910a–5	(*)
	Determination of calibration factor of bolometer unit at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.910b–1	WR90 (8.20–12.4 GHz)	(*)
201.910b–2	WR62 (12.4–18.0 GHz)	(*)
201.910b–3	WR137 (5.85–8.20 GHz)	(*)
201.910b–4	WR112 (7.05–10.0 GHz)	(*)
201.910b–5	WR187 (3.95–5.85 GHz)	(*)

[14] Desch, R. F., and R. E. Larson, Bolometric microwave power calibration techniques at NBS, IEEE Trans. Instr. Meas. IM–12, No. 1, 29 (June 1963).

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

ITEM	DESCRIPTION	FEE
201.910b–20	Determination of calibration factor of each additional bolometer unit at the same frequency as for 201.910b–1 to 201.910b–5	(*)
	Determination of calibration factor of bolometer-coupler unit at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.910c–1	WR90 (8.20–12.4 GHz)	(*)
201.910c–2	WR62 (12.4–18.0 GHz)	(*)
201.910c–3	WR137 (5.85–8.20 GHz)	(*)
201.910c–4	WR112 (7.05–10.0 GHz)	(*)
201.910c–5	WR187 (3.95–5.85 GHz)	(*)
	Determination of efficiency of bolometer unit at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.910d–1	WR137 (5.85–8.20 GHz)	(*)
201.910d–2	WR187 (3.95–5.85 GHz)	(*)
201.910d–20	Determination of efficiency of each additional bolometer unit at the same frequency as for 201.910d–1 to 201.910d–2	(*)
201.910z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.911 Waveguide dry calorimeters, continuous wave, low-level power.

ITEM	DESCRIPTION	FEE
201.911a–1	Measurement of output voltage versus input microwave power for dry calorimeter at a single frequency of WR90 waveguide (8.20–12.4 GHz) terminated with a standard waveguide connector at power levels from 10 mW to 1 W	(*)
201.911a–2	Each additional power level at the same frequency as for 201.911a–1	(*)
201.911z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.912 Coaxial bolometer units, continous wave, low-level power.

ITEM	DESCRIPTION	FEE
201.912a–1	Determination of effective efficiency of a coaxial bolometer unit at a single frequency in the range 4** to 10 GHz and a power level of 10 mW. Bolometer unit must be fitted with male Type N connector and thermistor-type element of nominal operating resistance of 200 ohms	(*)
201.912a–20	Determination of effective efficiency of each additional coaxial bolometer unit at the same frequency** as for 201.912a–1	(*)
201.912z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.
** For measurements on coaxial bolometer units below 4GHz, see Section 201.821.

201.920 Waveguide reflectors (mismatches), reflection coefficient magnitude.

(a) Reflection coefficient measurements are made on reflectors producing a reflection coefficient magnitude in the range of 0.024 to 0.2.

(b) Reflectors must be fitted with standard types of waveguide flanges. The faces of these flanges should be machined flat and smooth and should not contain protrusions or indentations. The connecting holes of the flange should be symmetrically and accurately aligned to the rectangular waveguide opening.

ITEM	DESCRIPTION	FEE
	Measurement of reflection coefficient magnitude of reflector at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.920a–1	WR90 (8.20–12.4 GHz)	(*)
201.920a–2	WR62 (12.4–18.0 GHz)	(*)
201.920a–3	WR137 (5.85–8.20 GHz)	(*)
201.920a–4	WR112 (7.05–10.0 GHz)	(*)
201.920a–5	WR187 (3.95–5.85 GHz)	(*)
201.920a–20	Measurement of reflection coefficient magnitude of each additional reflector at the same frequency as for 201.920a–1 to 201.920a–5	(*)
201.920z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.930 Cavity wavemeters, frequency measurement.

(a) Frequency measurements are made on fixed or variable cavity wavemeters of either the reaction (one-port) type or the transmission (two-port) type.

(b) Frequency measurements are made on fixed or variable cavity wavemeters having coaxial terminals with Type N connectors (male or female) in the frequency range of 1000 MHz to 10 GHz.

(c) Frequency measurements are made on fixed or variable cavity wavemeters having standard type waveguide terminals in the frequency range of 2.6 to 90 GHz.

ITEM	DESCRIPTION	FEE
201.930a	Measurement of resonance frequency of fixed cavity wavemeter	(*)
201.930b	Setting of adjustable cavity wavemeter at prescribed resonance frequency	(*)
201.930c–1	Calibration of dial setting versus resonance frequency of variable cavity wavemeter at initial prescribed frequency	(*)
201.930c–2	Calibration of dial setting versus resonance frequency of variable cavity wavemeter at each prescribed frequency additional to the initial frequency and on the same wavemeter as 201.930c–1	(*)
201.930z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.940 Waveguide variable attenuators, attenuation difference.

(a) Attenuation difference measurements are made on step or continuously variable attenuators, usually with the zero dial setting used as the reference position.

(b) Attenuation measurements are made for attenuation values from 0 to 50 dB. This range of attenuation values can be extended to 70 dB in some frequency ranges.

(c) Variable attenuators should have a repeatability of dial setting better than ± 0.1 dB.

(d) Variable attenuators should have a VSWR less than 1.1 at each waveguide port.

ITEM	DESCRIPTION	FEE
	Measurement of attenuation difference of direct-reading variable attenuator at an initial prescribed dial setting at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.940a–1	WR284 (2.60–3.95 GHz)	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

ITEM	DESCRIPTION	FEE
201.940a–2	WR187 (3.95–5.85 GHz)	(*)
201.940a–3	WR137 (5.85–8.20 GHz)	(*)
201.940a–4	WR112 (7.05–10.0 GHz)	(*)
201.940a–5	WR90 (8.20–12.4 GHz)	(*)
201.940a–6	WR62 (12.4–18.0 GHz)	(*)
201.940a–7	WR42 (18.0–26.5 GHz)	(*)
201.940a–8	WR28 (26.5–40.0 GHz)	(*)
201.940a–9	WR430 (1.70–2.60 GHz)	(*)
201.940a–20	Measurement of attenuation difference of direct-reading variable attenuator at each prescribed dial setting additional to the initial dial setting at the same frequency and on the same attenuator as for 201.940a–1 to 201.940a–9	(*)
201.940a–21	Measurement of attenuation difference of direct-reading variable attenuator at an initial prescribed dial setting at a single frequency as for 201.940a–5 to 201.940a–6, by means of modulated sub-carrier method to obtain greater accuracy of measurement	(*)
201.940a–22	Measurement of attenuation difference of direct-reading attenuator at each prescribed dial setting additional to the initial dial setting at the same frequency and on the same attenuator as 201.940a–21, by means of modulated sub-carrier method to obtain greater accuracy of measurement	(*)
	Calibration of dial setting versus attenuation difference for indirect-reading variable attenuator at an initial prescribed attenuation difference value at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.940b–1	WR284 (2.60–3.95 GHz)	(*)
201.940b–2	WR187 (3.95–5.85 GHz)	(*)
201.940b–3	WR137 (5.85–8.20 GHz)	(*)
201.940b–4	WR112 (7.05–10.0 GHz)	(*)
201.940b–5	WR90 (8.20–12.4 GHz)	(*)
201.940b–6	WR62 (12.4–18.0 GHz)	(*)
201.940b–7	WR42 (18.0–26.5 GHz)	(*)
201.940b–8	WR28 (26.5–40.0 GHz)	(*)
201.940b–9	WR430 (1.70–2.60 GHz)	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

ITEM	DESCRIPTION	FEE
201.940b–20	Calibration of dial setting versus attenuation difference for indirect-reading variable attenuator at each prescribed attenuation difference value additional to the initial attenuation difference value at the same frequency and on the same attenuator as 201.940b–1 to 201.940b–9	(*)
201.940b–21	Measurement of attenuation difference of indirect-reading variable attenuator at an initial prescribed dial setting at a single frequency as for 201.940b–5 to 201.940b–6, by means of modulated sub-carrier method to obtain greater accuracy of measurement	(*)
201.940b–22	Measurement of attenuation difference of indirect-reading attenuator at each prescribed dial setting additional to the initial dial setting at the same frequency and on the same attenuator as 201.940b–20, by means of modulated sub-carrier method to obtain greater accuracy of measurement	(*)
201.940z	Special calibrations not included in the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.941 Waveguide fixed attenuators, insertion loss.

(a) Insertion loss measurements are made on fixed two-port attenuators.

(b) Insertion loss measurements are made for insertion loss values from 0 to 50 dB. This range of attenuation values can be extended to 70 dB in some frequency ranges.

(c) Fixed attenuators should have a VSWR less than 1.1 at each waveguide port.

ITEM	DESCRIPTION	FEE
	Measurement of insertion loss of fixed attenuator at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.941a–1	WR284 (2.60–3.95 GHz)	(*)
201.941a–2	WR187 (3.95–5.85 GHz)	(*)
201.941a–3	WR137 (5.85–8.20 GHz)	(*)
201.941a–4	WR112 (7.05–10.0 GHz)	(*)
201.941a–5	WR90 (8.20–12.4 GHz)	(*)
201.941a–6	WR62 (12.4–18.0 GHz)	(*)
201.941a–7	WR42 (18.0–26.5 GHz)	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

ITEM	DESCRIPTION	FEE
201.941a–8	WR28 (26.5–40.0 GHz)	(*)
201.941a–9	WR430 (1.70–2.60 GHz)	(*)
201.941a–20	Measurement of insertion loss of additional fixed attenuator at the same frequency as for 201.941a–1 to 201.941a–9	(*)
201.941z	Special calibrations not included in the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.950 Waveguide noise sources, effective noise temperature.

(a) Effective noise temperature measurements are made on waveguide noise sources (usually a gas-discharge tube) under conditions of continuous, unmodulated operation in the range 1000 to 300,000 °K (excess noise ratio range 3.8 to 30 dB).

(b) The direct current required for normal operation of the gas-discharge tube should not exceed 300 mA but should be sufficient to prevent excessive plasma oscillations.

(c) The waveguide noise source must have an input VSWR no greater than 1.2.

(d) The gas-discharge tube should be secure in the mount, and the output port of the unit should be terminated with a matched load.

ITEM	DESCRIPTION	FEE
	Measurement of effective noise temperature of noise source at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.950a–1	WR90 (8.20–12.4 GHz)	(*)
201.950a–2	WR62 (12.4–18.0 GHz)	(*)
201.950a–20	Measurement of effective noise temperature of each additional noise source at the same frequency as for 201.950a–1 to 201.950a–2	(*)
201.950z	Special calibrations not covered by the above schedule	(*)

* As fees have not been fixed for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

* U.S. GOVERNMENT PRINTING OFFICE: 1967—251-025/91

CALIBRATION AND TEST SERVICES OF THE NATIONAL BUREAU OF STANDARDS

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

Change 14

Mass and Volume: All schedules under Mass and Volume, namely 202.620 through 202.628, which appear on pages 79-88 of MP 250, are cancelled and should be deleted. The fees for these services, listed on pages 127-128 of MP 250, are also to be deleted. These services have been revised as shown in schedules 202.630 through 202.633, which replace the previous Mass and Volume schedules. The text of the new schedules is given in this Insert.

This revision increases the scope of the services provided in the areas of mass and volume measurements. The charges for all services in these measurement areas are computed on the basis of actual cost (i.e., direct labor costs plus established overhead charges).

The following is a list of the schedules whose text is given below:

Mass and Volume

202.630	General.
202.631	Reference standards of mass.
202.632	Reference standard volumetric apparatus.
202.633	Density determinations of liquids and solids.

Mass and Volume

202.630 General.

(a) The Mass and Volume Section provides services to support the segments of the national measurement system which rely directly or indirectly on mass measurements. These services include the calibration of reference standards of mass, of glass and metal volumetric reference standards, and of reference standard hydrometers, also the density determinations of solids and liquids, and are offered only if suitable service is not otherwise available. In order to provide prompt and useful service, the acceptance of items for calibration or test is based on discussions with each user to determine details necessary to meet measurement and delivery requirements, and on inspection of the item at the

*Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of the insert are available from NBS Office of Technical Information and Publications.

Bureau with reference to its suitability for the usage intended. Sections 202.631, 202.632, and 202.633 apply to the calibration (or test) most frequently requested in each measurement area. The services of the Section, however, are not limited to these specific items. Inquiries are invited concerning other measurement problems in the above areas.

(b) Additional services are available which include the formulation of procedures (1) to establish a quantitative measure of the state of statistical control in the user's laboratory for measurement processes which involve mass, (2) to enable the user to monitor his calibration process, and (3) to assist in coordinated evaluation of the results. The nature of these services is described in NBS Technical Note 288 "Measurement Philosophy of the Pilot Program for Mass Calibration".[1]

(c) Arrangements for calibration (or test) must be completed before shipping apparatus to the Bureau. While all of the work of the section is on an actual cost basis, subject to a $25.00 minimum charge, a mutual agreement on the work to be performed generally results in substantial savings for the user. Detailed packing and shipping instructions are available on request. Items not accepted for calibration or test will be returned, the cost of inspection or the minimum charge being applicable.

(d) The results of a calibration (or test) will be reported either in a National Bureau of Standards Report of Calibration or Test (which in many cases is prepared by a computer program), a continuation report, or a letter report. In each of these, the values reported are accompained by an appropriate estimate of uncertainty (allowance for random and systematic errors) as determined by an analysis of the specific measurement process. A continuation report is used for those items submitted for recalibration on which preliminary tests indicate that no significant changes have occurred since the last calibration. A letter report is usually used to report a test for compliance with a specification which states limits for the departure of the actual value from nominal.

202.631 Reference Standards of Mass

(a) The Bureau's calibration of reference standards of mass provides extensions of the mass unit embodied in the NBS standards of mass. A normal calibration consists of establishing a mass value, and the appropriate uncertainty for that value, for each weight which has been designated to be a reference standard. It is desirable, but not necessary, that a weight should meet the adjustment tolerances established for Classes A, B, M, S, or S-1.

(b) Individual weights, or sets of weights, in the range of 30 kilograms to 1 milligram or 50 pounds to 1 micropound in decimal subdivisions, which are designated as reference standards, must be of design, material, and surface finish comparable to but not necessarily limited to present Class A, B, M, S, or S-1 as described in Circulars 3 and 547 in Volume III of NBS Handbook 77.[2] Design, material, and surface finish of large mass standards (over 50 lb to 50,000 lb) must be compatible with the intended usage. For these large mass standards, an adjustment with reference to a nominal or desired value can be included as a part of the calibration procedure.

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(1) Available at 30 cents per copy from Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

(2) Vol. III (Optics, Metrology, and Radiation) of NBS Handbook 77 is available at $7.00 per copy from Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

(c) The values of true mass (and an apparent mass correction) included in the report will be determined by using computed volumes based either on the manufacturer's statement of density of the material, on the density computed from measured volumes, or, in the absence of this information, on estimated density values. The apparent mass corrections are computed for 20°C with reference to Normal Brass (density 8.4 g/cm^3 at 0°C, volume coefficient of expansion 0.000054/C° in an ideal air density of 1.2 mg/cm . Apparent mass corrections to any other basis can be furnished if requested.

(d) For periodic recalibrations of reference mass standards, the user need only measure differences between weights or groups of weights within a set and compare them with computed differences. As long as the agreement is within allowable limits, the values can be considered constant within the precision of the comparison process. Mass standards which are submitted to the Bureau for recalibration are frequently tested in this manner. If these tests indicate that no significant changes have occurred, a continuation report so stating and referring to the previous NBS Report of Calibration will be issued.

Item	Description	Fee
202.631z	For calibration of reference mass standards or supporting services described in TN288[3], fees will be computed on a cost basis.	

202.632 Reference Standard Volumetric Apparatus

(a) The procedure almost universally used for testing glass volumetric apparatus is to weigh the amount of distilled water contained or delivered with reference to the graduations marked on the instrument, the volume being computed from the density of the water (for tables see NBS Circular 19, available on request[4]). The quality of the markings and the care exercised in reading or setting the liquid level are major factors in test calibration and usage. The Bureau will normally accept instruments for calibration which have volumes in the range of 1 mm to 1 gallon, and which essentially conform to requirements contained in NBS Circular 602 "Testing of Glass Volumetric Apparatus"[5], Federal Procurement Specifications NNN-B-00789 (Buret, straight, precision), NNN-F-00395a (Pipet, volumetric), NNN-P00350a (Pipet, measuring), or NNN-F-00289a (Flask, volumetric), if such instruments are to be used as reference or transfer standards.

(1) Groups of blood pipets which are used as factory standards for quality control will be accepted for test, and values will be furnished in a letter report.

(3) See footnote 1.

(4) From the Mass and Volume Section, Institute for Basic Standards, National Bureau of Standards, Washington, D. C. 20234.

(5) Available at 20 cents per copy from Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

(2) Suggested test procedures for the verification of the compliance of precision grade glassware with specifications and tolerances are available on request.

(b) The usual calibration procedure for metal volumetric apparatus consists of determining the value "to contain" or "to deliver" by either gravimetric means or by the use of transfer standards. The Bureau will normally accept instruments for calibration which have values in the range of 1 gill to 1000 gallons, which essentially comply with the specifications contained in NBS Monograph 62, "Testing of Volumetric Standards" [6], and which are free from dents, bumps or scratches.

(1) While it is preferred that the zero index or the gage scale be adjusted and sealed prior to calibration, these operations can be incorporated into the calibration procedure if requested. Slicker plate type standards should be adjusted by the manufacturer.

Item	Description	Fee
202.632z	For calibration of reference standard volumetric apparatus, fees will be computed on a cost basis.	

202.633 Density determinations of liquids and solids

(a) The usual procedure for determining the density of solids is hydrostatic weighing. At the Bureau liquid densities are usally determined by gravimetric methods. The picnometer can be filled at a specified temperature between 0° and 70°C. Other methods are available depending on the requirements. The Bureau will accept requests for density determinations if the need is critical, as in the support of scientific studies or standard sample programs. Limitations on the mass, physical dimensions or volume of the sample are available on request.

(b) Specific gravity hydrometers covering the range of 0.62 to 3, and proof spirit hydrometers in the range of 0 to 200 proof which are designated reference standard hydrometers (used to test other hydrometers) are normally accepted for calibration. A limited number of other types of reference standard hydrometers will be accepted for multi-point calibration subject to a discussion of detailed request. Instruments accepted must essentially comply with the requirements of NBS Circular 555, "Testing of Hydrometers".[7]

Item	Description	Fee
202.633z	For density determination of liquids or solids or the calibration of reference standard hydrometers fees will be computed on a cost basis.	

(6) Available at 15 cents per copy from Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

(7) Available at 10 cents per copy from Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

CALIBRATION AND TEST SERVICES OF THE NATIONAL BUREAU OF STANDARDS

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

Change 15

Dosimetry in High-Energy Electron Beams: This insert gives the text of a new schedule, 204.503, which describes a measurement service that has been added to the other radiation-physics measurements in Part 204 of MP250.

The new schedule is as follows:

204.503 Dosimetry in high-energy electron beams.

(a) The Bureau will prepare and mail dosimeters to users requesting assistance with absorbed-dose measurements in high-energy electron beams. The dosimeters employed will consist of ferrous sulfate (Fricke) solution in radiation-resistant silica-glass spectrophotometer cells. The users will expose all but two of the furnished dosimeters to between 5,000 and 8,000 rads at electron energies between 5 and 50 MeV, employing the exposure geometry (field size, phantom, position of dosimeter in phantom) given in the "Protocol for Dosimetry of High-Energy Electrons," Physics in Medicine and Biology 11,505 (1966).

(b) After irradiation, the dosimeters will be returned to the Bureau for spectrophotometric evaluation of the ferric-ion concentration in terms of absorbed dose in the phantom, using the G-value given in the Protocol. The results of this evaluation will be reported to the users.

(c) The Bureau plans to provide this service four times a year starting on or about July 1, 1967, and to offer it quarterly thereafter.

*Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of the insert are available from NBS Office of Technical Information and Publications.

Item	Description	Fee
204.503a	Preparing and shipping four Fricke dosimeters, two as controls, and two for irradiation; evaluating the ferric-ion content in terms of absorbed dose in the phantom; reporting the test results.	**$250.00
204.503b	For an additional fee an additional Fricke dosimeter may be supplied and its ferric-ion content evaluated after irradiation.	**50.00

**Through a subsidy provided by the National Center for Radiological Health, Public Health Service, Department of Health, Education, and Welfare, a reduction in fee may become available to all medical users interested in a check of the absorbed dose calibrations employed in high energy electron beam therapy. For details contact the Dosimetry Section, Radiation Physics Division, National Bureau of Standards, Room C-209, Radiation Physics Building, Washington, D. C. 20234.

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(This announcement is from the Federal Register, Vol. 32, No. 45—Wednesday, March 8, 1967).

CALIBRATION AND TEST SERVICES OF THE NATIONAL BUREAU OF STANDARDS

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

Change 16

Electricity, Microwave Region: Insert 8 describes (See table below) two new calibration services that have been added to Section 201.912, "Coaxial bolometer units, continuous wave, low-level power." This sheet should be inserted after page 20 of Insert 5, where the most recent revision of Section 201.912 is given.

Both of the new services are for the measurement of effective efficiency of coaxial bolometer units fitted with 14-mm precision coaxial connectors over a continuous frequency range from 4 to 8.5 GHz. Use of 14-mm precision coaxial connectors permits greater accuracy of measurement of radio frequencies than with the older type N connectors. At present the measurements are available at a nominal power of 10 milliwatts and for bolometer units fitted with thermistor-type elements having a nominal operating resistance of 200 ohms.

Item	Description	Fee
201.912a-2	Determination of effective efficiency of a coaxial bolometer unit at a single frequency in the range of 4[1] to 8.5 GHz and a power level of 10 mw. Bolometer unit must be fitted with a 14 mm general precision connector[2] and a thermistor-type element for nominal operating resistance of 200 ohms.	(**)
201.912a-21	Determination of effective efficiency of each additional coaxial bolometer unit at the same frequency as for 201.912a-2.	(**)

*Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of the insert are available from NBS Office of Technical Information and Publications, Washington, D. C. 20234.

**As fixed prices have not been established for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

(1) For measurements on coaxial bolometer units below 4 GHz, see Section 201.821 (p. 6 of Insert 5).

(2) "Precision Coaxial Connectors," Recommendations of the IEEE I-M Group Subcommittee on Precision Coaxial Connectors, Revised July 10, 1966. This report describes the mechanical, electrical, and environmental requirements for precision coaxial connectors. It is available upon request from: Chairman, IEEE G-1M Technical Committee on High Frequency Instruments and Measurements, The Institute of Electronic Engineers, Inc., 345 East 47th Street, New York, New York 10017.

(This announcement is from the Federal Register, Vol. 32, No. 65-Wednesday, April 5, 1967).

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CALIBRATION AND TEST SERVICES OF THE NATIONAL BUREAU OF STANDARDS

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

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Change 17

Electricity, High-Frequency Region: Insert 9 gives the text of two new Sections, 201.870 and 201.871, describing a new service for the measurement of phase-angle shift by insertion of coaxial phase shifters (precision air- or dielectric-filled line) and variable-type coaxial phase shifters. The initial service is at a frequency of 30 MHz.

This sheet should be inserted after page 20 of Insert 5 which gives the most recent over-all revision of the services provided by the NBS Radio Standards Laboratory.

201.870 Coaxial phase shifters, precision air- or dielectric-filled line.

(a) Phase shifters are calibrated by insertion into a 50-ohm coaxial line. A VSWR of any reasonable magnitude for the phase shifter is acceptable; the measurement uncertainty will be adjusted to the VSWR relation.

(b) The phase shifter must be fitted with Type N or TNC connectors or precision-type connectors.

Item	*Description*	*Fee*
201.870a	Measurement of phase angle shift by insertion of a coaxial phase shifter (precision air- or dielectric-filled line) in coaxial line at MHz.	(**)
201.870z	Special calibrations not covered by the above schedule.	(**)

*Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of the insert are available from NBS Office of Technical Information and Publications, Washington, D. C. 20234.

**As fixed prices have not been established for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

201.871 Coaxial phase shifters, variable type.

(a) Phase shifters are calibrated by insertion into a 50-ohm coaxial line. A VSWR of any reasonable magnitude for the phase shifter is acceptable; the measurement uncertainty will be adjusted to the VSWR relation.

(b) Measurements will be performed at any specified phase angle(s).

(c) Phase shifters should have a repeatability of setting better than 0.1 degree.

(d) The phase shifter must be fitted with Type N or TNC connectors or precision-type connectors.

Item	*Description*	*Fee*
201.871a	Measurement of phase angle shift at initial setting by insertion of variable-type coaxial phase shifter in coaxial line at MHz.	(**)
201.871b	Measurement of phase angle shift at each setting additional to the initial setting as for 201.871a.	(**)
201.871z	Special calibrations not covered by the above schedule.	(**)

**As fixed prices have not been established for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual coss.

CALIBRATION AND TEST SERVICES OF THE

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Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

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Change 18

Electricity, Microwave Region: Insert 10 gives the text of three new items, 201.910a-6, 201.910b-6, and 201.910c-6, which expand to an additional waveguide size (WR42: 18.0 to 26.5 GHz) the present service for measuring the effective efficiency and calibration factor of bolometer-coupler units.

This sheet should be inserted after page 18 of Insert 5, which gives the most recent over-all revision of the services provided by the NBS Radio Standards Laboratory.

Section 201.910 Waveguide bolometer units and bolometer-coupler units, continuous wave, low-level power.

Item	Description	Fee
201.910a-6	Measurement of effective efficiency of bolometer unit at a single frequency of the following waveguide size terminated with standard waveguide connector: WR42 (18.0-26.5 GHz)	(**)
201.910b-6	Measurement of calibration factor of bolometer unit at a single frequency of the following waveguide size terminated with standard waveguide connector: WR42 (18.0-26.5 GHz)	(**)
201.910c-6	Measurement of calibration factor of bolometer-coupler unit at a single frequency of the following waveguide size terminated with standard waveguide connector: WR42 (18.0-26.5 GHz)	(**)

*Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of the insert are available from NBS Office of Technical Information and Publications.

**As fixed prices have not been established for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

CALIBRATION AND TEST SERVICES OF THE

NATIONAL BUREAU OF STANDARDS

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

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Change 19

Metrology: Insert 11 reports three changes in the schedules of Part 202, Metrology:

(1) Section 202.108, Reflectometry, is deleted. The deleted section appeared on pages 55-56 of MP 250.

(2) Items 202.114a and 202.114h of Section 202.114, Radiometry, are deleted.

(3) The text of Section 202.202 has been revised (see below) and the name of the section has been changed to "Photogrammetry". The title was formerly "Photographic Objectives" and the section appeared on pages 58-61 of MP 250.

The revised text of Section 202.202, Photogrammetry, is as follows:

202.202 Photogrammetry.

The following information is pertinent to the tests a to i in this schedule:

a. and b. This is a test of the definition characteristics of a lens. It is performed photographically. In general, if a lens yields satisfactory results when subjected to this test, it is probable that no additional test for lateral chromatic aberration is necessary.

c. This is a qualifying test for photographic objectives for aerial mapping cameras. It is a photographic test and the determinations are made for the plane of best average definition.

d. and e. The f-number is the ratio of the equivalent focal length of the lens to the diameter of the effective aperture.

f. This is a test of the platen of a precision aerial mapping camera which is the surface against which the film is held during exposure. It is a test to determine conformance to specifications requiring that the platen shall not depart from a true plane by more than ±12 microns (±0.0005 in.).

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g. This is a test of a photographic objective mounted in a camera. It gives the same information as test 202.202c except for back-focal distance. It is preferable that these lens characteristics be determined for the lens as mounted in a barrel shutter but occasionally it is desirable to determine these quantities for the lens mounted in a camera. The shutter should be open when the camera is submitted for test.

h. This is a test of a lens-camera combination for photogrammetric mapping. It gives the departure of the principal point of auto-collimation from the center of collimation which is the intersection point of lines joining opposite pairs of collimation index markers. The radial distortion is determined with respect to the calibrated focal length of the lens.

This test cannot be performed on a camera having a detachable magazine which bears the collimation index markers. This is the preliminary test on a precision type camera to determine compliance with specification. If no provision has been made for ready adjustment of the collimation index markers and they are not aligned at 90°, the camera is returned for adjustments. If the 90° condition is satisfied but no provision has been made for ready adjustment of the principal point with respect to the center of collimation, the camera is returned for adjustments.

i. If the principal point can be properly positioned with respect to the center of collimation by ready adjustment of the lens in a transverse direction or by ready movement of the collimation index markers, this is done in the course of the test. Following adjustment, pins are set to preserve the setting.

When a camera is submitted for test, the drill holes for the pins, a proper sized drill and reamer, and a sufficient number of pins to perform the doweling must accompany the camera. It is desired that roll pins be submitted for this task.

THE TABLE OF INDIVIDUAL ITEMS OF THIS

SCHEDULE IS GIVEN ON THE FOLLOWING PAGE

Item	Description	Fee
202.202a	Determination of resolving power at 5° intervals from center to edge of field for collimated light at one aperture.	$ 97.00
202.202b	Fee for each additional aperture.	50.00
202.202c	Determination of back-focal distance, equivalent focal power at 5° intervals from the center to edge of the field. This is the test usually required for lenses that are to be mounted in precision aerial cameras.	135.00
202.202d	Determination of equivalent focal length and true geometric f-number for one marked stop.	78.00
202.202e	Fee for each additional stop.	19.00
202.202f	Determination of compliance of camera platen with flatness requirements to ±0.0005 in.	28.00
202.202g	Determination of calibrated focal length, radial and tangential distortion, and resolving power at 7.5° intervals from center to edge of field for lens mounted in camera.	185.00
202.202h	Location of the principal point of autocollimation, check of 90° condition for lens mounted in camera, and radial distortion.	165.00
202.202i	Setting the principal point of autocollimation and 90° condition, checking and doweling for lens mounted in camera.	135.00
202.202z	For special tests not covered by the above schedule, fees charged depend on the nature of the test.	

CALIBRATION AND TEST SERVICES OF THE NATIONAL BUREAU OF STANDARDS

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

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Change 20

General policies and procedures: Insert 12 is a revision of the whole of "Part 200 -- General". It restates and expands the statement of policies and procedures relating to various measurement services, including calibrations and tests. The entire text of Part 200, which appears on pages 5 through 10 of MP250, 1965 Edition, should be deleted; and this insert should be placed after page 4.

The revised text of Part 200 follows:

PART 200 -- GENERAL

Sec.

200.100 Statutory functions
200.101 Measurement research
200.102 Standards for measurement
200.103 Types of calibration and test services
200.104 Consulting and advisory services
200.105 Standard reference materials
200.106 Critically evaluated data
200.107 Publications
200.108 Broadcasts
200.109 Request procedure
200.110 Shipping, insurance, and risk of loss
200.111 Identification and operability of devices submitted
200.112 Priority and time of completion
200.113 Witnessing of operations
200.114 Reports
200.115 Use of results
200.116 Fees
200.117 Billing charges

*Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of the insert are available from NBS Office of Technical Information and Publications.

20.109 Statutory functions.

(a) The National Bureau of Standards has been assigned the following functions (15 U.S.C. 271-278e):

(1) The custody, maintenance, and development of the national standards of measurement, and the provision of means and methods for making measurements consistent with those standards, including the comparison of standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognized by the Government.

(2) The determination of physical constants and properties of materials when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere.

(3) The development of methods for testing materials, mechanisms, and structures, and the testing of materials, supplies, and equipment, including items purchased for use of Government departments and independent establishments.

(4) Cooperation with other governmental agencies and with private organizations in the establishment of standard practices, incorporated in codes and specifications.

(5) Advisory service to Government agencies on scientific and technical problems.

(6) Invention and development of devices to serve special needs of the Government.

(b) The calibration and testing activities of the Bureau stem from the functions in paragraph (a) (1) and (3) of this section. These activities are assigned primarily to the NBS Institute for Basic Standards. Its program provides the central basis within the United States for a complete and consistent system of physical measurement; coordinates that system and the measurement system of other nations; and furnishes essential services leading to accurate and uniform physical measurements throughout the Nation's scientific community, industry, and commerce.

(c) The provision of standard reference materials for sale to the public is assigned to the Office of Standard Reference Materials

200.100 (contd.)

of the NBS Institute for Materials Research. It evaluates the requirements of science and industry for carefully characterized reference materials, stimulates the Bureau's efforts to develop methods for production of needed reference materials and directs their production and distribution. The items available under this program are listed in Subchapter B of this chapter.

(d) The provision of technical services to facilitate technical innovation and industrial use of the results of modern science and technology is assigned to the NBS Institute for Applied Technology. The principal elements of the Institute are (1) a Textiles and Apparel Technology Center furnishing specialized technical services to that industry; (2) technical divisions which provide services in technology of more general applicability; (3) the Clearinghouse for Federal Scientific and Technical Information which promotes widest effective use by the scientific community, industry, and commerce of current information in all fields of industrial technology; and (4) a Center for Computer Sciences and Technology which conducts research and provides technical services designed to improve cost effectiveness in the conduct of agency programs through the use of computers and related techniques.

200.101 Measurement research.

(a) The NBS Institute for Basic Standards carries out the Bureau's function in developing an adequate national system of physical measurement, and in providing related calibration services. Its staff continually reviews the advances in science and the trends in technology, examines the measurement potentialities of newly discovered physical phenomena, and uses these to devise and improve standards, measuring devices, and measurement techniques. As new requirements appear, there are continual shifts of program emphasis to meet the most urgent needs for the measurement of additional quantities, extended ranges, or improved accuracies.

(b) The basic research and development activities of the Bureau are primarily funded by direct appropriations, and are aimed

at meeting broad general needs. When necessary, the Bureau also undertakes investigations or developments to meet some specialized physical measurement problem of another government agency, industrial group, or manufacturing firm, using funds supplied by that organization.

200.102 Standards for measurement.

(a) An international treaty, the Metric Convention, was signed by 18 countries in 1875. In 1893 the United States established prototype No. 27 of the international meter bar and prototype No. 20 of the international kilogram as United States Prototype Standards for length and mass. Representatives of many of the 80 nations now adhering to this treaty meet periodically, in the General Conference of Weights and Measures, to consider detailed proposals concerning international standards for physical measurement. The 11th Conference (1960) redefined the meter in terms of wavelengths of krypton 86 light, and agreed to adopt six units to serve as a practical base for an International System of Units (abbreviated SI from the French, Système International) - kilogram, meter, second, degree Kelvin, ampere, and candela. These are arbitrarily chosen but precisely defined magnitudes of six quantities of the physical world - mass, length, time, temperature, electric current and luminous intensity, respectively - which are assigned unitary value in the International System. The units of the English System - pound, inch, second, degree Fahrenheit, etc. - and of other systems of units are related to the SI units by agreed-upon conversion factors. Consistent units for all other physical quantities needed by science and technology can be derived from, and their numerical values are fixed by, these SI units.

The SI units for the six quantities are defined as follows:

(1) In terms of a prototype object:

(1.1) Mass: The kilogram is the mass of a platinum-iridium cylinder preserved at the International Bureau of Weights and Measures in Sèvres, France. Prototype No. 20 is kept at NBS; equivalent prototypes are kept by other countries.

200.102 (contd.)

(2) In terms of natural phenomena:

(2.1) Length: The meter is the length of exactly 1,650,763.73 wavelengths of radiation in vacuum corresponding to the unperturbed transition between the levels $2p_{10}$ and $5d_5$ of the atom of krypton 86, the orange-red line.

(2.2) Time interval: The second was long defined as 1/86400 of the time required for an average complete rotation of the earth on its axis with respect to the sun. This led to the universal time scale (UT). Because of the slight slowing of the earth's average rotation rate (from 5 to 6 ms per year, each year), and other larger random fluctuations, the universal second thus defined is not a constant. The 11th Conference (1960) ratified the following definition: "the second is the fraction 1/31,556,925.9747 of the tropical year for January 0,1900 at 12 o'clock ephemeris time." The 12th Conference (1964) authorized the designation of an atomic standard of frequency to be used temporarily for the physical measurement of time. The standard designated is "the transition between the hyperfine levels F = 4, M = 0, and F = 3, M = 0 of the ground state $2S_{1/2}$ of the cesium 133 atom not perturbed by external fields, and the value 9,192,631,770 hertz is assigned to the frequency of this transition." Experimental evidence indicates that the two alternative definitions of the second are consistent within expected uncertainties.

(2.3) Temperature: The degree Kelvin is 1/273.16 of the thermodynamic temperature range between the triple point of water and absolute zero.

(2.4) Electric Current: The ampere is that constant current which if maintained in two straight parallel conductors of infinite length, of negligible circular sections, and placed 1 meter apart in a vacuum, would produce between these conductors a force equal to 2×10^{-7} newton per meter of length.

(2.5) Luminous intensity: The candela is the luminous intensity of 1/60 of one square centimeter of projected area of a blackbody radiator at the temperature of freezing platinum.

2[illegible].102 (contd.)

(b) Although the six base units, and others derived from them, are exactly defined, their practical use requires a realization through the development of accurate measurement standards. Measurement standards may be based on physical phenomena, specimen objects, signal sources, or reference instruments. Extensive theoretical studies and laboratory experiments are involved in their selection, design, construction, and operation.

It will be noted that a kilogram mass standard can be calibrated only through a series of comparisons, starting from the International Prototype. The units for the other five base quantities, and all quantities derived from them, are in principle independently realizable in many laboratories. In practice, however, inevitable minor differences among instruments, environments, and operators are bound to introduce small discrepancies. Periodic comparison of standards and the resolution of these discrepancies is required for compatibility among domestic standards laboratories, as well as internationally.

Within the United States, NBS consults with the major industrial and governmental standards laboratories, and cooperates with the Department of Defense and the National Conference of Standards Laboratories in conducting measurement agreement comparisons. Periodic inter-comparisons of Bureau standards with those of other countries are made through the International Bureau of Weights and Measures, through international scientific organizations, or by direct arrangement. The operations of the International Bureau are supervised by the General Conference of Weights and Measures, to which U. S. delegates are appointed by the Department of State.

Frequency and time comparisons within the United States are made between the National Bureau of Standards, the United States Naval Observatory, and manufacturers of frequency standards. The data from world-wide astronomical observations and from standards laboratories in many countries are coordinated by the International Bureau of the Hour, which announces recommended approximations for the rate difference between atomic and universal time, as well as for

200.102 (contd.)
epoch adjustments.

200.103 Types of calibration and test services.

(a) The Bureau has developed instrumentation and techniques for realizing standards for the six base units of the International System of Units, as agreed upon by the General Conference of Weights and Measures. Reference standards have been established not only for these six base units, but also for many derived quantities and their multiples and submultiples. Such reference standards, or equivalent working standards, are used to calibrate laboratory and plant standards for other organizations. Accuracy is maintained by stability checks, by comparison with the standards of other national and international laboratories, and by the exploration of alternative technique as a means of reducing possible systematic error.

(b) Calibrations for many types of instruments and ranges of physical quantities are described in the itemized schedules of this Subchapter. (See also NBS Miscellaneous Publication 250*, "Calibration and Test Services of the National Bureau of Standards"). Charges for many services are based upon established fees, while charges for some services are billed on the basis of actual costs incurred. (See subsequent Parts of this Subchapter for description of service items and schedule of fees). Changes in services and fees are published in the Federal Register. Such changes are announced also in supplements to Miscellaneous Publication 250 and in the monthly NBS Technical News Bulletin.*

(c) Consideration will always be given to requests involving unusual physical quantities, upper or lower extremes of range, higher levels of accuracy, fast response speeds, short durations, broader ranges of associated parameters, or special environmental

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200.103 (contd.)

conditions. Such inquiries should describe as clearly as possible the measurement desired and the scientific or economic basis for the requirement to be satisfied.

(d) The Bureau's principal emphasis is on those calibrations and other tests requiring such accuracy as can be obtained only by direct comparison with its reference standards. However, in order to maintain efficient utilization of specialized equipment and skilled personnel, NBS will at times undertake upon request to calibrate devices requiring lesser accuracy but suitable for working standards in plant or laboratory.

(e) Other services which may be obtainable include:

(1) Tests of measuring instruments to determine compliance with specifications or claims, when the evaluation is critical in national scientific or technical operations, and when suitable facilities are not available elsewhere.

(2) Referee tests in important cases when clients are unable to agree upon the method of measurement, the results of tests, or the interpretation of these results, but have agreed in advance in writing to accept and abide by the findings of the Bureau.

(f) In general, measurement services are not provided for organizations or individuals in foreign countries.

(g) The Bureau reserves the right to decline any request for services if the work would interfere with other activities deemed by the Director to be of greater importance.

200.104 Consulting and advisory services.

(a) In areas of its special competence, the Bureau offers consulting and advisory services on physical or mathematical problems related to measurement, e.g. unusual or extreme conditions, methods of statistical control of the measurement process automated acquisition of laboratory data, and data reduction and analysis by computer. The Bureau at its discretion may make appropriate charges for rendering such services; the charges would be based upon actual costs.

200.104 (contd.)

(b) To enhance the competence of standards laboratory personnel, the Bureau conducts annually several group seminars on the precision measurement of specific types of physical quantities, offering the opportunity of laboratory observation and informal discussion. A 2-week summer course in electromagnetic measurements and standards is conducted biennially by the NBS Radio Standards Laboratory.

(c) Suggestions will be offered on measurement techniques and on other sources of assistance on calibration or measurement problems when the Bureau's own equipment and personnel are unable to undertake the work. The National Conference of Standards Laboratories issues a Directory of Standards Laboratories in the United States (obtainable from NCSL Secretariat, c/o National Bureau of Standards, Washington, D. C. 20234.) Others are listed in the ASTM Directory of Testing Laboratories, Commercial and Institutional. (Directory available from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103). Similar listings appear in buyer's guides for commercial products and in technical journals concerned with physical measurement.

200.105 Standard reference materials.

Often the performance of a device or structure can be evaluated at the user's laboratory by comparing its response to unknown values with its response to a standardized specimen or a material of certified composition, properties, or purity. Several types of such specimens are listed in Part 202 of this Subchapter. (See also NBS Miscellaneous Publication 250*). Carefully characterized materials are listed in Part 230 of Subchapter B of Chapter II, Title 15 of the Code of Federal Regulations. (See also Miscellaneous Publication 260*, "Standard Reference Materials"). The Office of Standard Reference Materials in the NBS Institute for Materials Research administers a

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program to provide all types of well-characterized materials that are needed to calibrate a measurement system or to produce scientific data that can be readily referred to a common base.

200.106 Critically evaluated data.

Data on the physical properties of the thousands of well-defined substances which are commercially available need to be compiled and evaluated to be useful for reference in engineering design. The Office of Standard Reference Data in the NBS Institute for Basic Standards provides two-way communication with a number of governmental and non-governmental data centers throughout the country. Its compilation and dissemination activities cover seven technical areas - nuclear data, atomic and molecular data, solid state data, thermodynamic and transport data, chemical kinetics, solloid and surface properties, and mechanical properties. Monthly accounts of progress appear in the National Standard Reference Data System News (available upon request from the Office of Standard Reference Data) and in the Technical News Bulletin.*

200.107 Publications.

The monthly NBS Technical News Bulletin * announces changes in services and fees, as published in the Federal Register. The Bulletin also describes recent results of Bureau staff work, lists currently issued publications, and carries sections giving up-to-date detailed information on standards and calibrations, standard reference materials, and the National Standard Reference Data System. A 6-year index to publications by Bureau authors will be found in a Supplement* to Miscellaneous Publication 240, Publications of the National Bureau of Standards, for July 1, 1960 to June 30, 1966. The index covers Monographs,* Technical Notes,* and all papers appearing either in the NBS Journal of Research* or in outside technical journals.

Unclassified research and development reports from all government agencies and their contractors are listed in a semi-monthly Government-

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200.107 (contd.)
wide Index available from the NBS Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151. Publication series available from the Clearinghouse include Report Abstracts, Fast Announcement Service, Package Reviews, and Technical Translations.

200.108 Broadcasts.

The Radio Standards Laboratory of NBS broadcasts various types of standard frequency and time signals from 4 radio stations: WWV, WWVH, WWVL, and WWVB. (NBS Miscellaneous Publication 236*, "NBS Standard Frequency and Time Services", contains information concerning the broadcasts of various types of such signals from these four stations.) WWVH is located at Maui, Hawaii. WWV, WWVL, and WWVB are located at Fort Collins, Colorado. (WWV was relocated in December 1966 from Greenbelt, Maryland.) Notices of precisions, accuracies, and adjustments in NBS clocks and radio emissions are published regularly in the Federal Register. (Such notices are published also in the Time and Frequency Service Bulletin which is available from the Radio Standards Laboratory on request.)

Broadcasts from WWV are at nominal frequencies of 2.5, 5, 10, 15, 20, and 25 MHz, and from WWVH at 2.5, 5, 10, 15 MHz; the carrier frequencies and time pulse rates emitted by both are offset from nominal values in accordance with the Universal Time Coordinated (UTC) system. The frequency is offset by -300 parts in 10^{10}, and the time pulses occur at intervals slightly longer than one second. As recommended by the International Bureau of the Hour, the phase of the time pulses is occasionally adjusted to approximate UT2 within about 100 ms. The UT2 scale is a partly smoothed version of Universal Time (UT), as determined by astronomical observations and with annual and semi-annual fluctuations removed. WWV and WWVH also provide standard musical pitch at 440 hertz, weather forecasts, and geophysical alerts. WWV broadcasts Universal Time - seconds, minutes, hours, and days of the year - in the code format of the National Aeronautics and Space Administration. For more precise determination of UT2, both WWV and WWVH broadcast in International Morse Code appropriate

200.108 (contd.)

corrections based on astronomical data from the U. S. Naval Observatory, Washington, D. C.

At WWVL, the modes of broadcast of the carrier and the timing signals are also in conformity with the UTC system.

Station WWVB broadcasts on the standard radio frequency of 60 KHz without offset, emitting time marker pulses exactly 1 second apart, as determined by the NBS cesium clock. The phase of these pulses is re-set every few months by 0.2-s adjustments, as recommended by the International Bureau of the Hour, in order to approximate UT2 within about 0.1 s. This is a coordinated system known as Stepped Atomic Time (SAT).

The U.S. Naval Observatory also broadcasts standard UTC time and time interval (frequency), using both astronomical and atomic data. It coordinates a number of Navy and Coast Guard stations around the globe, and also monitors the NBS broadcasts. Both USNO and NBS monitor broadcasts from selected laboratories in foreign countries, and issue periodic comparisons of reference signals.

200.109 Request procedure.

(a) A formal purchase order for the calibration or test should be sent prior to or at the time of shipment. This should provide clear identification of the instrument or standard being submitted, and give instructions for billing. If a client wishes to minimize the time during which his equipment is out of service, he can usually arrange to delay shipment until the test is scheduled to start. Requests from Federal agencies, or from State agencies, for calibrations or tests on material to be used on private or Federal contract work, should be accompanied either by purchase order or by letter or document authorizing the cost of the test to be billed to the agency.

(b) Acceptance of purchase orders does not imply acceptance of any provisions set forth in the order contrary to the policy, practice, or regulations of the National Bureau of Standards or the U. S.

200.109 (contd.)

Government. (A statement to the effect that the National Bureau of Standards is an agency of the U. S. Government should satisfy other Government agencies with regard to compliance with Government regulations and executive orders.)

(c) A test number will be assigned by the Bureau to each item (instrument or group of similar instruments or standards) when accepted for test. This test number should be referred to in all subsequent communications. If the apparatus submitted has been previously calibrated by the Bureau, reference should be made to the test number previously assigned, so that a continuing record of stability history can be established.

(d) Inquiries related to electrical standards in the radio frequency region (above 30 kHz, Part 201, sections 201.701 through 201.950 of this Subchapter), and on all frequency and time standards should be directed to:

Coordinator, Calibration Services
Radio Standards Laboratory
National Bureau of Standards
Boulder, Colorado 80302

(e) Inquiries for measurement services listed in this Subchapter, other than those noted in par. (d) of this section, should be directed to:

Test Administration Unit
National Bureau of Standards
Washington, D. C. 20234

200.110 Shipping, insurance, and risk of loss.

(a) Shipment of material to the Bureau for calibration or other test should be made only after the client has accepted the estimate of cost and the tentative scheduling.

(b) Calibrations of electrical standards in the radio frequency region (above 30 kHz, Part 201, sections 201.701 through 201.950 of this Subchapter) are performed at Boulder, Colorado. Shipments should be addressed to:

Coordinator, Calibration Services
Radio Standards Laboratory
National Bureau of Standards
Boulder, Colorado 80302

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If apparatus for high frequency is also to be given incidental low-frequency calibration, this may be done at Boulder, Colorado, but if a complete range of low-frequency tests are needed, the instrument should be sent to:

National Bureau of Standards
Route 70S & Quince Orchard Rd.
Gaithersburg, Md.

(c) The calibrations listed in this Subchapter, other than those noted in par. (b) of this section, are performed in the Bureau's laboratories at either Gaithersburg, Md. or Washington, D. C. For shipments which are heavy (in excess of 100 lbs.) or bulky (a combined girth in excess of 27 cubic ft.), request a shipping address from:

Test Administration Unit
National Bureau of Standards
Washington, D. C. 20234

Items other than heavy or bulky shipments that are sent by common carrier, should be addressed to:

National Bureau of Standards
Route 70S & Quince Orchard Rd.
Gaithersburg, Md.

(d) Equipment sent to the Bureau must be properly packed to minimize likelihood of damage in shipment and handling. Suggestions on packing and shipping are made in some sections of the fee schedule. In every case, the client should consider the nature of the equipment, pack it accordingly, and clearly label shipments containing fragile instruments or materials, such as glass and the like. The use of "security express" should be considered in shipping delicate instruments.

(e) To minimize damage during shipment resulting from inadequate packing, the use of strong reusable containers is recommended. As an aid in preventing loss of such containers, the client's name should be legibly and permanently marked on the outside. In order to prolong the container's use, the notation REUSABLE CONTAINER, DO NOT DESTROY should be marked on the outside.

(f) Shipping and insurance coverage instructions, in order to

200.110 (contd.)

be followed, must be clearly and legibly shown on the purchase order for the calibration or test. As the Bureau will not pay shipping or insurance charges and add this cost to the billing invoice, return shipment, when no shipping or insurance instructions are furnished, will be made by common carrier collect, but uninsured.

(g) When a test number has been assigned prior to shipment to the Bureau, this number should be clearly marked on the shipping container. When a test number has not been assigned, an invoice, copy of the purchase order, or letter should be enclosed in the shipment to insure proper identification. The original purchase order should be forwarded as appropriate to:

Test Administration Unit
National Bureau of Standards
Washington, D. C. 20234

Coordinator, Calibration Services
Radio Standards Laboratory
National Bureau of Standards
Boulder, Colorado 80302

(h) NBS will not be responsible for the risk of loss or damage to any item in shipping to or from the Bureau. Any arrangements for insurance covering this risk must be made by the client. Return shipment will be made by the Bureau as indicated in par. (f) of this section. The purchase order should always show the value of the equipment, and if transit insurance is carried by the client, this fact should be stated.

(i) The risk of loss or damage in handling or testing of any item by NBS must be assumed by the client, except when it is determined by the Bureau that such loss or damage was occasioned solely by the negligence of Bureau personnel.

200.111 Identification and operability of devices submitted.

(a) Since the data provided by the Bureau's report is specific to the individual item or piece of apparatus tested, it is essential that this piece be identified uniquely by an appropriate number or symbol. In most cases, the manufacturer's name and serial numbers

200.111 (contd.)

are used. When such a number is lacking, an alternative identifying mark should be provided. If none is found, the Bureau may apply an appropriate one, usually the Bureau's Test Number, for which an additional charge may be made.

(b) All apparatus submitted for calibration and test must be in good operating condition. Repairs and adjustments should be attended to by the client prior to shipment. Apparatus not in good condition cannot be tested, nor can the Bureau undertake the repair or adjustment of any equipment, except by special arrangement. If it is evident that equipment has been abused or has not received proper care, a test ordinarily will not be conducted. If defects are found at the Bureau after a test has begun, this fact will be reported, the test may be terminated, and a report issued summarizing such information as has been found, and a fee charged in accordance with the amount of work done.

200.112 Priority and time of completion.

(a) Except for emergency Government work, calibrations and other tests are in general undertaken in the order in which requests are received.

(b) The date at which a test will be completed depends on a number of factors, such as the condition of submitted equipment, setup time, duration of test run, limitations on available personnel, occasional large backlogs of work, and grouping of tests of similar devices to lessen costs. Sometimes repetitive runs are needed to determine reliability of results, or peculiar behavior is noted, requiring unusually careful investigation. The Bureau will cooperate with a client to minimize the out-of-use time for his equipment, and will upon request inform him of a probable starting date and give notice of unexpected delays in completion of the work. Estimates of completion dates are therefore provisional.

200.113 Witnessing of operations.

The Bureau welcomes scientists and engineers who may wish to

200.113 (contd.)

visit its laboratories and discuss its methods. However, visitors ordinarily will not be permitted to witness the actual carrying out of highly precise measurements because their presence introduces distraction that may lead to errors or delays. This policy may be waived in those cases where the visitor can be of service in setting up apparatus of a new or unusual nature, in the case of referee tests, or in other cases in which the legal validity of the result may require the presence of duly authorized witnesses.

200.114 Reports.

Results of calibrations and other tests are issued as reports entitled, "National Bureau of Standards Report of Calibration", "National Bureau of Standards Report of Test", or "National Bureau of Standards Report of Analysis", as appropriate. The report form used carries no special significance. Whenever formal certification is required by law, or to meet special conditions adjudged by the National Bureau of Standards to warrant it, a letter will be provided certifying that the particular item was received and calibrated or tested, and identifying the report containing the results.

200.115 Use of results.

(a) The NBS report of calibration or test contains data which pertain only to the particular device or specimen calibrated or tested. There is no implication that other items of the same lot or type will show comparable results. However, on the basis of tests on a sample of instruments or objects drawn from a lot of nominally identical items, in accordance with an approved sampling procedure, the Bureau may declare that the entire lot does or does not meet stated requirements for acceptance.

(b) The results given in the NBS report are limited to the condition of the equipment at the time of calibration or test. Clients should not assume that comparable performance will be sustained unless suitable precautions are taken in handling and use.

(c) The National Bureau of Standards does not "approve,"

200.115 (contd.)
"recommend," or "endorse" any proprietary product or material, either as a single item or as a class or group. Results reported by the Bureau shall not be used in advertising or sales promotion, or to indicate explicit or implicit endorsement of the product or material by the Bureau.

200.116 Fees.

(a) In accordance with 15 U. S. C. 271-278e, fees are charged for all calibrations and tests made by the National Bureau of Standards.

(b) This fee schedule is published subject to the above-mentioned basic act which authorizes the Secretary of Commerce, from time to time, to make regulations regarding the payment of fees, the limits of tolerance on standards submitted for verification, and related matters.

200.117 Billing charges.

The minimum billing charge for any test request accepted by the Bureau is $10, unless otherwise indicated in a particular fee schedule. If apparatus is returned without testing, a minimum charge of $10 may be made to cover handling. Fees for tests include the cost of preparation of an original report. Additional copies ordinarily are not issued to other than the recipient of the original, and are not issued unless the client has shown a technical need for them. Copies of reports requested subsequent to the date of tests will be supplied at cost, with a minimum charge of $5. All checks should be made payable to NBS, Department of Commerce.

USCOMM-NBS-DC

CALIBRATION AND TEST SERVICES OF THE NATIONAL BUREAU OF STANDARDS

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

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Change 21

Appendix C: Insert 13 contains a list of all fees that have been established as of June 1967 for services described in Misc. Publ. 250. Attention is called to changes in fees for Part 201 (Electricity), Part 202 (Metrology), Part 203 (Heat), and Part 206 (Mechanics), many of which have not been noted in previous inserts. The schedule which follows is applicable to the electrical, photometric, dimensional, thermal, radiation, and mechanical measurements, as recently published in Parts 201 (Sections 201.101 through 201.604), 202, 203, 204, and 206 of the Federal Register CFR 15, Chapter II, Subchapter A. This schedule supersedes in its entirety the Appendix C of the NBS Miscellaneous Publication 250, "Calibration and Test Services of the National Bureau of Standards", 1965 edition, pages 125 through 129. The original pages should be removed and the new schedule inserted in their place.

To meet increasing costs of the Bureau's calibration and test services, it has been found necessary to raise the stated fees rather generally. The following tabulation lists the fees that have been established for measurement services described in the schedules. The items included here are identified in the schedules by a single asterisk (*) in the Fee column.

For further information on NBS policy in regard to fees, see Part 200, as given in Insert 12, dated June 30, 1967, especially Sections 200.116 and 200.117, and the various sections with the title "General" (see Contents of MP 250).

Items carrying the suffix "z" are automatically excluded from the list, since these services, and consequently also the fees for them, vary according to the requirements of the individual case, as agreed upon in advance by the client and the NBS laboratory concerned.

Change 22

Effective July 1, 1967, calibration charges made to public customers by the Electronic Calibration Center (ECC) will be increased. Charges which were previously $20.00 per hour will be $40.00 per hour; charges which were previously $25.00 per hour will be $45.00 per hour. These charges affect calibration services in the high frequency and microwave regions (30 kHz and up) which are performed by the Radio Standards Laboratory at Boulder, Colorado. The services of the Radio Standards Laboratory are described in Insert 5, dated April 3, 1967; Insert 8, dated April 17, 1967; Insert 9, dated June 15, 1967; and Insert 10, dated June 16, 1967.

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*Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of the insert are available from NBS Office of Technical Information and Publications, Washington, D. C. 20234.

Electricity

Item	Fee
Precision standard resistors	
201.101a-1	$ 40.00
201.101a-2	50.00
201.101a-3	70.00
201.101b-1	65.00
201.101b-2	75.00
201.101c-1	150.00
201.101c-2	175.00
Precision resistance apparatus	
201.102a (1)	20.00
(2)	5.00
201.102b	195.00
201.102c	70.00
201.102d-1	520.00
201.102d-2	705.00
201.102e	300.00
201.102f	555.00
201.102g	215.00
201.102h	630.00
201.102i-1	350.00
201.102i-2	435.00
201.102i-3	475.00
201.102j	110.00
201.102k	110.00
201.102l	285.00
201.102m	520.00
Multi-megohm resistance standards	
201.103a	$ 60.00
201.103b	70.00
201.103c	80.00
Standard inductors	
201.104a	75.00
201.104b	60.00
Standard capacitors	
201.105a	50.00
201.105b	20.00
Standard cells	
201.201a	45.00
201.201b	95.00
201.201c	50.00
201.201d	120.00
201.201e	60.00
Standard resistors	
201.301a-1	100.00
201.301a-2	160.00
201.301b	30.00
201.301c	45.00
201.301d	160.00
201.301e	45.00
201.301f	410.00
Volt boxes (fixed ratio voltage dividers)	
201.302a	$150.00
201.302b	30.00
201.302c	10.00
201.302d	30.00
Ac-dc instruments and thermal converters	
201.303a	80.00
201.303b	20.00
201.303c	35.00
Ac-dc wattmeters, single phase	
201.304a	95.00
201.304b	35.00
201.304c	15.00
Watthour meters	
201.305a	115.00
201.305b	15.00
201.305c	60.00
201.305d	10.00
Current transformers	
201.306a-1	180.00
201.306a-2	210.00
201.306b-1	30.00
201.306b-2	45.00
201.306c	10.00
Current transformer comparators	
201.307a	540.00
201.307b	60.00
Normal induction and hysteresis	
201.401a	70.00
201.401b	80.00
201.401c	140.00
201.401d	70.00
201.401e	50.00
201.401f	25.00
201.401g	10.00
Magnetic materials: a-c permeability and core loss	
201.402a	45.00
201.402b	15.00
201.402c	45.00
201.402d	15.00
Magnetic testing apparatus	
201.403a	35.00
201.403b	20.00
201.403c	40.00
201.403d	25.00
201.403e	45.00
201.403f	10.00
201.403g	30.00-70.00

Item	Fee
Voltage dividers	
201.601a	$140.00
201.601b	85.00
Voltage transformers	
201.602a-1	120.00
201.602a-2	165.00
201.602a-3	90.00
201.602a-4	130.00
201.602b	22.00
201.602c	20.00
201.602d	33.00
201.602e	11.00
Kilovoltmeters	
201.604a	110.00
201.604b	90.00
201.604c	28.00
201.604d	11.00
Metrology	
Miscellaneous photometric measurements	
202.103a	90.00
Incandescent electric lamps	
202.104a	35.00
202.104b	10.00
Spectrophotometric standards	
202.105a	160.00
202.105b	60.00
202.105c	15.00
202.105d	80.00
202.105e	80.00
202.105f	125.00
202.105g	140.00
202.105h	140.00
202.105i	175.00
202.105j	175.00
202.105k	175.00
202.1051	100.00
202.105m	100.00
202.105n	175.00
Spectrophotometric measurements	
202.106a	80.00
202.106b	8.00
202.106c	8.00
202.106d	80.00
202.106e	8.00
202.106f	8.00
202.106g	95.00
202.106h	15.00
202.106i	130.00
202.106j	25.00
202.106k	95.00
202.1061	15.00
Spectrophotometric measurements--Continued	
202.106m	$130.00
202.106n	25.00
202.106o	40.00
Colorimetry	
202.107a	20.00
202.107b	15.00
202.107c	12.00
202.107d	50.00
202.107e	12.00
202.107f	20.00
202.107g	50.00
202.107h	50.00
202.107i	55.00
202.107j	20.00
202.107k	140.00
Opacimetry	
202.109a	60.00
202.109b	180.00
Lovibond glasses	
202.111a	60.00
202.111b	25.00
Signal glass limit glasses and IPL calibrating filters	
202.112a	250.00
202.112b	90.00
202.112c	15.00
Radiometry	
202.114b	90.00
202.114c	90.00
Visual measurements of optical characteristics	
202.201a	46.00
202.201b	94.00
202.201c	180.00
202.201d	250.00
202.201e	110.00
202.201f	180.00
202.201g	275.00
202.201h	250.00
202.201i	110.00
202.201j	385.00
202.201k	110.00
Photogrammetry	
202.202a	97.00
202.202b	50.00
202.202c	135.00
202.202d	78.00
202.202e	19.00
202.202f	28.00

Item	Fee
Photogrammetry--Continued	
202.202g	$185.00
202.202h	165.00
202.202i	135.00
Modulation transfer function measurements of lenses	
202.207a	200.00
202.207b	88.00
Photography	
202.311a	33.00
202.311b	33.00
202.311c	33.00
202.311d	11.00
202.311e	36.00
202.311f	11.00
Working line standards of length	
202.402a	165.00
202.402b	81.00
202.402c	3.00
Steel tapes	
202.404a	36.00
202.404b	7.00
202.404c	7.00
202.404d	7.00
202.404e	6.00
202.404f	7.00
202.404g	7.00
202.404h	6.00
202.404i	7.00
202.4041	10.00
202.404m	20.00
202.404n	7.00
202.404o	20.00
202.404p	7.00
Invar base-line tapes	
202.405a	200.00
202.405b	52.00
202.405c	26.00
202.405d	26.00
202.405e	295.00
202.405g	10.00
202.405h	20.00
202.405i	7.00
202.405j	20.00
202.405k	7.00
202.4051	60.00
202.405m	22.00
Surveyors' measuring instruments	
202.406a	62.00
Sieves	
202.407a	18.00

Item	Fee
Haemacytometers	
202.408a	$ 8.00
202.408b	11.00
202.408c	9.00
202.408d	22.00
202.408e	23.00
Gage blocks	
202.412a	10.00
202.412b	30.00
202.412ab	740.00
202.412c	16.00
202.412d	45.00
202.412cd	1,250.00
202.412e	12.00
202.412f	70.00
End standards of length	
202.501a	14.00
202.501b	20.00
202.501c	24.00
202.501d	28.00
202.501e	28.00
202.501f	38.00
202.501g	48.00
202.501h	56.00
Plain cylindrical plug and ring gages	
202.502a	14.00
202.502b	41.00
202.502c	59.00
202.502d	59.00
202.502e	89.00
202.502f	115.00
Thread plug and ring gages	
202.503a	36.00
202.503b	36.00
202.503c	89.00
202.503d	115.00
202.503e	71.00
202.503f	115.00
202.503g	130.00
202.503h	89.00
202.503i	27.00
202.503j	36.00
202.503k	71.00
202.5031	36.00
202.503m	59.00
202.503n	165.00
202.503o	100.00
202.503p	125.00
202.503q	82.00
202.503r	115.00
202.503s	175.00
202.503t	175.00
202.503u	120.00

Item	Fee
Instruments and components	
202.504a	$ 54.00
202.504b	38.00
202.504c	6.00
202.504d	8.00
202.504e	18.00
202.504f	5.00
202.504g	6.00
202.504h	4.00
202.504i	27.00
Optical reference planes	
202.505a	82.00
202.505b	120.00
202.505c	175.00
Angle blocks	
202.506a	410.00
Polygons	
202.507a	205.00
202.507b	235.00
202.507c	295.00
202.507d	355.00
202.507e	470.00
202.507f	600.00
202.507g	1,000.00
Master balls	
202.508a	12.00
202.508b	18.00
202.508c	29.00
202.508d	71.00
Gears	
202.509a(1)	190.00
202.509a(2)	235.00
Heat	
Laboratory thermometers	
203.101a	16.00
203.101b	27.00
203.101c	45.00
203.101d	47.00
203.101e	74.00
203.101f	100.00
203.101g	110.00
203.101h	2.00
203.101i	4.00
Thermocouples, thermocouple materials, pyrometer indicators	
203.102a	115.00
203.102b	34.00
203.102c	100.00
203.102d	370.00
203.102e	3.00
203.102f	45.00
203.102g	$ 38.00
203.102h	65.00
Thermocouples, thermocouple materials, pyrometer indicators--Continued	
203.102i	54.00
203.102j	20.00
Resistance thermometers	
203.103a	225.00
203.103b	300.00
203.103c	225.00
203.103d	590.00
203.103e	95.00
203.103f	40.00
203.103g	34.00
203.103h	15.00
Optical pyrometers and ribbon filament lamps	
203.105a	250.00
203.105b	165.00
203.105c	130.00
203.105d	225.00
203.105e	120.00
203.105f	3.00
Cryogenic Physics	
Capsule-type germanium resistance thermometers	
203.301a	1,000.00
Radiation Physics	
Gamma-emitting radioactive samples	
204.201a (1)	110.00
204.201a (2)	110.00
204.201b	135.00
Alpha-emitting radioactive samples	
204.202a	88.00
Beta-emitting radioactive samples	
204.203a	285.00
204.203b	150.00
X-ray and gamma-ray instruments	
204.501a	48.00
204.501b	18.00
204.501c	60.00
204.501d	24.00
204.501e	42.00
204.501f	17.00
Gamma-ray sources	
204.502a	18.00
204.502b	28.00
204.502c	40.00
Neutron sources	
204.701a	$ 557.00
Neutron instruments	
204.702a	107.00

Item	Fee
Neutron irradiation of foils	
204.703a	81.00
Mechanics	
Acoustic measurements	
206.011a	280.00
206.011b	445.00
206.011c	465.00
206.011d	485.00
206.011e	1,240.00
206.011f	640.00
206.011g	480.00
206.011h	125.00
206.011i	480.00
206.011j	650.00
Hardness tests	
206.041a	73.00
Load cells with remote-reading electrical indicators	
206.042a	205.00
206.042b	225.00
206.042c	270.00
206.042d	230.00
206.042e	240.00
206.042f	325.00
206.042g	425.00
206.042h	460.00
206.042i	670.00
206.042j	590.00
206.042k	640.00
206.0421	940.00
Special mechanical tests of devices, materials and structures	
206.043a	20.00
206.043b	11.00
Proving rings	
206.044a	280.00
206.044b	445.00
206.044c	205.00
206.044d	280.00
206.044e	400.00
206.044f	650.00
206.044g	290.00
206.044h	455.00
206.044i	$ 880.00
206.044j	1,425.00
206.044k	530.00
206.0441	1,026.00
206.044m	1,175.00
206.044n	1,925.00
206.044o	760.00
206.044p	1,175.00
Elastic force measuring devices	
206.045a	230.00
206.045b	245.00
206.045c	330.00
206.045d	300.00
206.045e	330.00
206.045f	455.00
206.045g	520.00
206.045h	560.00
206.045i	930.00
206.045j	690.00
206.045k	790.00
206.0451	1,200.00
Vibration pickups	
206.231a	145.00
206.231b	200.00
206.231c	580.00
206.231d	580.00
206.231e	445.00
Humidity instruments	
206.241a	660.00
206.241b	1,375.00
206.241c	725.00
206.241d	1,570.00
206.241e	495.00
206.241f	970.00
206.241g	915.00
206.241h	1,265.00
206.241i	350.00
206.241j	165.00
206.241k	375.00
206.2411	200.00
Fluid meters, including gas-measuring instruments	
206.311a	90.00
206.311b	275.00
206.311c	420.00
206.311d	650.00
206.311e	42.00
206.311f	200.00
206.311g	56.00
206.311h	72.00
206.311i	160.00
206.311j	7.00
206.311k	15.00
Aerodynamical measurements	
206.331a	170.00
Building Research*	
Thermal conductivity	
210.601a	150.00
210.601b	1,750.00
210.601c	1,225.00
210.601d	1,350.00

*Changes in the following are still under consideration.

CALIBRATION AND TEST SERVICES OF THE

NATIONAL BUREAU OF STANDARDS

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

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Change 23

Electricity, High-Frequency Region: Insert 14 adds two new items, 201.822c and 201.822d, to Section 201.822--Pulse power, peak measurement, coaxial systems. For convenience, the text of the entire section, including the two new items, is given below.

This sheet should be inserted after page 6 of Insert 5 (dated April 3, 1967), the last over-all revision of the services provided by the NBS Radio Standards Laboratory. The previous version of Section 201.822, on page 7 of Insert 5, should be deleted.

201.822 Pulse power, peak measurement, coaxial systems.

(a) Instruments submitted for calibration should have a nominal impedance of 50 ohms and be fitted with Type N, BNC, HN, or precision input connectors.[13]

(b) Measurements are made with pulsed rf signals having a rectangular envelope.

ITEM	DESCRIPTION	FEE
201.822a	Calibration of instrument for measuring peak power of pulsed signals in coaxial systems, in the frequency range of 950 to 1200 MHz, at a peak power in the range of 1 mW to 3 kW; at a pulse width in the range of 2 to 10 μsec, and at a pulse repetition rate in the range of 100 to 1600 pps with a maximum duty cycle of 0.0033 ----------	(**)
201.822b	Calibration of instrument for measuring peak power of pulsed signals in coaxial systems at each additional peak power level or a different pulse width or pulse repetition rate, at the same frequency as for 201.822a ----------	(**)
201.822c	Calibration of instrument for measuring peak power of pulsed signals in coaxial systems, in the frequency range of 300 to 500 MHz, at a peak power in the range of 1 mW to 2.5 kW; at a pulse width in the range of 2 to 10 μsec, and at a pulse repetition rate in the range of 100 to 1600 pps with a maximum duty factor of 0.0033 ----------	(**)
201.822d	Calibration of instrument for measuring peak power of pulsed signals in coaxial systems at each additional peak power level or a different pulse width or pulse repetition rate, at the same frequency as for 201.822c ----------	(**)
201.822z	Special calibrations not covered by the above schedule ----------	(**)

[13] See Section 201.800.

*Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of the insert are available from NBS Office of Technical Information and Publications.

**As fixed prices have not been established for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs. See also Insert 13, Change 22.

CALIBRATION AND TEST SERVICES OF THE

NATIONAL BUREAU OF STANDARDS

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

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Change 24

Building Research: The services described in Section 210.201, Fire Resistance Tests of Building Materials, have been discontinued since there is no longer a demand at the National Bureau of Standards for tests of this type. The text of Section 210.201, page 112 of MP 250, 1965 edition, therefore, should be deleted.

Change 25

Building Research: Section 210.601, Thermal Conductivity, has been revised in two ways: (1) The fee for item 201.601a is increased from $150 to $160. The former fee, page 6 of Insert 13 (June 10, 1967) of MP 250, should be deleted and the new fee entered. (2) The fees for the other tests described previously in Section 210.601 are canceled and the text of these items (210.601b through 210.601d), page 113 of MP 250, 1965 edition, should be deleted. These tests are now grouped under item 210.601z for which fees are based on the nature of the test and the time required. As before, for determination of thermal conductivity of a metal specimen, the required sample is a cylindrical bar 46.0 cm long and approximately 2.54 cm uniform diameter.

Below is given the complete revised text of Part 210, Building Research, which can be inserted after page 112 of MP 250, 1965 edition:

210.601 Thermal Conductivity.

Item	Description	Fee
210.601a	Determination for calibration purposes of the thermal conductivity of a selected pair of specimens by means of guarded hot-plate apparatus (conforming to ASTM C177) for mean temperatures between 0 and 130 °F (ordinarily 0, 30, 75, and 130 °F), per determination at one mean temperature----------	$160
210.601z	Determination of thermal conductivity of a metal specimen for a range of mean temperature from -150 to 750 °C. Required sample is a cylindrical bar 46.0 cm long and approximately 2.54 cm uniform diameter----------	**
	**Fees have not been fixed for these services. Charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual cost.	

*Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of the insert are available from NBS Office of Technical Information and Publications, Washington, D. C. 20234.

Change 26

Neutron Physics: The fees for the three Neutron Physics measurement services have been revised upwards to reflect the increase in cost since 1965, as follows:

Item	New Fee
204.701a	$560
204.702a	110
204.703a	90

The old fees, listed on pages 5 and 6 of MP 250 Insert 13 (June 30, 1967), should be deleted and the new fees entered.

CALIBRATION AND TEST SERVICES OF THE

National Bureau of Standards

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

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Change 27

Calibration of gamma-, beta-, and alpha-emitting radioactive samples: The revised text of schedules 204.201, 204.202, and 204.203 given in this insert supersedes the text of these same schedules as given both in MP 250, pages 93 to 95, and in Insert 4, dated April 3, 1967.

The version of schedules 204.201, 204.202, and 204.203 on pages 93 to 95 of MP 250 therefore should be deleted (if this was not done when Insert 4 was issued); Insert 4 should be discarded; and the present insert should replace Insert 4 after page 92 of MP 250.

Changes also have been made in most of the fees, revising them upward to yield full recovery of the cost of providing the services. The old fees, on page 5 of Insert 13, should be deleted and the new ones written in.

Other changes are: (1) the addition of mercury-197 to the list of samples referred to in items 204.201a(2)iii and 204.202aiii, and (2) the text of the "z" item at the end of each schedule has been reworded.

204.201 Calibration of gamma-emitting radioactive samples.

Calibration of gamma-emitting radioactive samples that conform to the physical, chemical, and activity level specifications for measurement in the National Bureau of Standards' $4\pi\gamma$-ionization chamber:

Item	Description	Fee
204.201a	(1) 100-300 micrograms of radium (2) Chemically stable solutions of the following radionuclides in the specified activity ranges can be measured: i. 50-100 microcuries of sodium-22, sodium-24, scandium-46, cobalt-60, yttrium-88. ii. 150-300 microcuries of manganese-54, iron-59, zinc-65, strontium-85, niobium-95, iodine-131, cesium-137, tantalum-182, gold-198, mercury-203. iii. 300-600 microcuries of potassium-42, cobalt-57, cerium-139, cerium-141, mercury-197. Solutions should be 5 ml in volume and flame-sealed in glass vials or ampoules of O.D. 16.0 ± 0.5 mm, wall thickness approximately 0.5 mm.....	$120.

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Item	Description	Fee
204.201b	Chemically stable solutions of the following radionuclides in the specified activity ranges can be measured: i. 10-20 microcuries of sodium-22, sodium-24, scandium-46, cobalt-60, yttrium-88. ii. 30-60 microcuries of manganese-54, iron-59, zinc-65, strontium-85, niobium-95, iodine-131, cesium-137, tantalum-182, gold-198, mercury-203. iii. 60-100 microcuries of potassium-42, cobalt-57, cerium-139, cerium-141, mercury-197. Solutions should be 5 ml in volume and flame-sealed in glass vials or ampoules of O.D. 16.0 ± 0.5 mm, wall thickness approximately 0.5 mm.....	$135.
204.201z	Fees have not been fixed for these services and charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual cost.	

204.202 Calibration of alpha-emission rate of sources.

Calibration of alpha-emitting radioactive samples that conform to the physical and activity level specifications for measurement in the National Bureau of Standards' $2\pi\alpha$-proportional counter:

Item	Description	Fee
204.202a	Chemically stable samples that conform to the physical and activity level specifications listed below can be measured: i. Source diameter should not exceed 10 cm. ii. Source thickness should be such that more than 99.5% of the emitted alpha particles have an energy greater than 400 keV. iii. Emission rate should not exceed 5×10^3 ps.....	$92.
204.202z	Fees have not been fixed for these services and charges will be made for actual cost incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual cost.	

204.203 Calibration of beta-emitting radioactive samples.

Calibration of beta-emitting radioactive samples that conform to the physical, chemical, and activity level specifications for measurement in either the National Bureau of Standards' $2\pi\beta$-windowless proportional flow counter or in the Bureau's $2\pi\beta$-ionization chamber:

Item	Description	Fee
204.203a	Chemically stable solutions of the following radionuclides in the specified activity ranges can be measured in the Bureau's $2\pi\beta$ -windowless proportional flow counter: i. 1-10 microcuries/milliliter of chlorine-36, strontium-yttrium-90. ii. 2-20 microcuries/milliliter of thallium-204. iii. 5-50 microcuries/milliliter of calcium-45, promethium-147. iv. 10-100 microcuries/milliliter of sulfur-35. Solutions should be approximately 5 ml in volume and flame-sealed in glass vials or ampoules.....	$305.
204.203b	Chemically stable solutions of the following radionuclides in the specified activity ranges can be measured in the Bureau's $2\pi\beta$ -ionization chamber: i. 2-20 microcuries/milliliter of phosphorus-32. Solution should be neutral or weak acid with not more than 0.2 mg/ml total solids. ii. 2-20 microcuries/milliliter of strontium-89, strontium-yttrium-90. Solution should be weak HCl (1N or less) with not more than 0.2 mg/ml total solids. Solutions should be approximately 5 ml in volume and flame-sealed in glass vials or ampoules.....	$155.
204.203z	Fees have not been fixed for these services and charges will be made for actual cost incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual cost.	

CALIBRATION AND TEST SERVICES OF THE NATIONAL BUREAU OF STANDARDS

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

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Change 28

Policies, services, procedures, and fees: Insert 17 is a revision of the whole of "Part 200—General," whose title is now changed to "Part 200—Policies, Services, Procedures, and Fees." It supersedes Insert 12, dated June 30, 1967, as well as the still earlier version on pages 5 to 10 of MP 250, 1965 Edition. Insert 12 should be discarded and replaced by the present insert which should be inserted after page 4 of MP 250, 1965 Edition.

Attention is called to the first paragraph of the following page and to schedule 200.116 of this insert, which imply that upon publication of this revision of Part 200 in the Federal Register, official announcements concerning the details of NBS measurement services will appear in MP 250 and its supplements (Inserts) rather than in the Federal Register. (In regard to standard reference materials in the program of the NBS Institute for Materials Research, a similar arrangement will be made shortly, with official announcements to be made in MP 260, "Catalog and Price List of Standard Materials Issued by the National Bureau of Standards.")

The revised text of Part 200 follows:

PART 200—GENERAL

Sec.

200.100 Statutory functions.
200.101 Measurement research.
200.102 Standards for measurement.
200.103 Types of calibration and test services.
200.104 Consulting and advisory services.
200.105 Standard reference materials.
200.106 Critically evaluated data.
200.107 Publications.
200.108 Broadcasts.
200.109 Request procedure.
200.110 Shipping, insurance, and risk of loss.
200.111 Priorities and time of completion.
200.112 Witnessing of operations.
200.113 Reports.
200.114 Use of results or reports.
200.115 Fees and bills.
200.116 Description of services and list of fees, incorporation by reference.

*Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of the insert are available from the NBS Office of Technical Information and Publications.

This revision, effective upon publication in the Federal Register, restates the policies and procedures relating to the National Bureau of Standards' measurement services and incorporates by reference NBS Miscellaneous Publication 250 (MP 250), "Calibration and Test Services of the National Bureau of Standards." MP 250 states NBS policies, describes NBS measurement services in detail, prescribes the procedures for obtaining such services, and lists the fees charged.

200.100 Statutory functions.

(a) The National Bureau of Standards has been assigned the following functions (15 U.S.C. 271-278e):

(1) The custody, maintenance, and development of the national standards of measurement and the provision of means and methods for making measurements consistent with those standards, including the comparison of standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognized by the government.

(2) The determination of physical constants and properties of materials when such data are of great importance to scientific or manufacturing interests and are not to be obtained with sufficient accuracy elsewhere.

(3) The development of methods for testing materials, mechanisms, and structures and the testing of materials, supplies, and equipment, including items purchased for use of government departments and independent establishments.

(4) Cooperation with other governmental agencies and with private organizations in the establishment of standard practices, incorporated in codes and specifications.

(5) Advisory service to government agencies on scientific and technical problems.

(6) Invention and development of devices to serve special needs of the Government.

(b) The calibration and testing activities of the Bureau stem from the functions in paragraphs (a)(1) and (3) of this Section. These activities are assigned primarily to the NBS Institute for Basic Standards. Its program provides the central basis within the United States for a complete and consistent system of physical measurement; coordinates that system and the measurement systems of other nations; and furnishes essential services leading to accurate and uniform physical measurements throughout the Nation's scientific community, industry, and commerce.

(c) The provision of standard reference materials for sale to the public is assigned to the Office of Standard Reference Materials of the NBS Institute for Materials Research. It evaluates the requirements of science and industry for carefully characterized reference materials, stimulates the Bureau's efforts to develop methods for production of needed reference materials, and directs their production and distribution. For information on standard reference materials, see Subchapter B, Chapter II, Title 15, of the Code of Federal Regulations.

(d) The provision of technical services to facilitate technical innovation and industrial use of the results of modern science and technology is assigned to the NBS Institute for Applied Technology. The principal elements of the Institute are: (1) a Center for Computer Sciences and Technology which conducts research and provides technical services designed to improve cost effectiveness in the conduct of agency programs through the use of computers and related techniques; (2) technical divisions which provide services in technology of more general applicability; and (3) the Clearinghouse for Federal Scientific and Technical Information which promotes widest effective use by the scientific community, industry, and commerce of current information in all fields of industrial technology.

200.101 Measurement research.

(a) The NBS Institute for Basic Standards carries out the Bureau's functions in developing an adequate national system of physical measurement and in providing related calibration services. Its staff continually reviews the advances in science and the trends in technology, examines the measurement potentialities of newly discovered physical phenomena, and uses these to devise and improve standards, measuring devices, and measurement techniques. As new requirements appear, there are continual shifts of program emphasis to meet the most urgent needs for the measurement of additional quantities, extended ranges, or improved accuracies.

(b) The basic research and development activities of NBS are funded primarily by direct appropriations and are aimed at meeting broad general needs. Also the Bureau may undertake investigations or developments to meet some specialized physical measurement problem of another government agency, industrial group, or manufacturing firm, using funds supplied by the requesting organization.

200.102 Standards for measurement.

(a) An international treaty, the Metric Convention, was signed by 18 countries in 1875. In 1893 the United States established prototype No. 27 of the international meter bar and prototype No. 20 of the international kilogram as United States Prototype Standards for length and mass. Representatives of many of the 40 nations now adhering to this treaty meet periodically, in the General Conference of Weights and Measures, to consider detailed proposals concerning international standards for physical measurement. Successive Conferences now have agreed to adopt six units to serve as a practical base for an International System of Units (Système International d'Unités, abbreviated SI)—kilogram, meter, second, kelvin, ampere, and candela. These are arbitrarily chosen but precisely defined magnitudes of six physical quantities—mass, length, time, temperature, electric current, and luminous intensity, respectively—which are assigned unitary value in the International System. Because the system is coherent, the expressions for the other quantities of science and technology derived from these six through the equations of physics will have unitary coefficients also. The units of the English system—pound, inch, second, degree Fahrenheit, etc.—and of other systems of units are related to the SI units by agreed-upon conversion factors.

(b) The SI units for the six quantities are defined as follows:

(1) In terms of a prototype object:

(i) Mass: The kilogram is the mass of a platinum-iridium cylinder preserved at the International Bureau of Weights and Measures in Sèvres, France. Prototype No. 20 is kept at NBS; equivalent prototypes are kept by other countries.

(2) In terms of natural phenomena:

(i) Length: The meter is the length of exactly 1,650,763.73 wavelengths of radiation in vacuum corresponding to the unperturbed transition between the levels $2p_{10}$ and $5d_5$ of the atom of krypton 86, the orange-red line.

(ii) Time interval: The second was long defined as 1/86400 of the time required for an average complete rotation of the earth on its axis with respect to the sun. This, with daily corrections from zenith transits of a star, is the basis for a universal time scale (UT). With further correction for polar motion, it becomes UT1, and with further correction for annual seasonal variations, UT2. Also, the earth' s average daily rotation rate has been decreasing, thereby increasing the length of each year by about 6 ms over the length of the preceding year. Because of this, and other larger random fluctuations, the universal second thus defined is not a constant. Consequently, the 11th Conference (1960) ratified the definition of a second based on ephemeris time (ET): "the fraction 1/31,556,925.9747 of the tropical year for January 0, 1900 at 12 o'clock ephmeris time." The 12th Conference (1964) authorized the designation of a cesium atom transition as a standard of frequency to be used temporarily for the physical measurement of time. The 13th Conference (1967) abrogated the 1960 action and decided that: The unit of time of the International System of Units is the second, defined in the following terms: "The second is the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the fundamental state of the atom of cesium 133."

(iii) Temperature: The kelvin, the unit of thermodynamic temperature, is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water. It was decided by the 13th Conference that the same name, kelvin, and the symbol K should be used for expressing temperature intervals, dropping the former convention which expressed a temperature interval in degrees Kelvin or as abbreviated, deg K. However, the old designations are acceptable temporarily as alternatives to the new ones. One may also express temperature intervals in degrees Celsius.

(iv) Electric current: The ampere is that constant current which if maintained in two straight parallel conductors of infinite length, of negligible circular sections, and placed 1 meter apart in a vacuum, would produce between these conductors a force equal to 2×10^{-7} newton per meter of length.

(v) Luminous intensity: The candela is the luminous intensity, in the direction of the normal, of a blackbody surface 1/600,000 square meter in area, at the temperature of solidification of platinum under a pressure of 101,325 newtons per square meter.

(c) Although the six base units, and others derived from them, are exactly defined, their practical use requires a realization through the development of accurate measurement standards. Measurement standards may be based on physical phenomena, specimen objects, signal sources, or reference instruments. Extensive theoretical studies and laboratory experiments are involved in their selection, design, construction, and operation.

(d) It will be noted that a kilogram mass standard can be calibrated only through a series of comparisons, starting from the International Prototype. The units for the other five base quantities, and all quantities derived from them, are in principle independently realizable in many laboratories. In practice, however, inevitable minor differences among instruments, environments, and operators are bound to introduce small discrepancies. Periodic comparison of standards and the resolution of these discrepancies is required for compatibility among domestic standards laboratories, as well as internationally.

(e) Within the United States, NBS consults with the major industrial and governmental standards laboratories and cooperates with the Department of Defense and the National Conference of Standards Laboratories in conducting measurement agreement comparisons. Periodic intercomparisons of NBS standards with those of other countries are made through the International Bureau of Weights and Measures, through international scientific organizations, or by direct arrangement. The operations of the International Bureau are supervised by the General Conference of Weights and Measures to which U.S. delegates are appointed by the Department of State.

(f) Frequency and time comparisons within the United States are made by the National Bureau of Standards, the United States Naval Observatory, and other organizations which have an interest in precise time and frequency standards. The data from world-wide astronomical observations and from standards laboratories in many countries are coordinated by the International Bureau of the Hour, which announces recommended approximations for the rate difference between atomic and universal time, as well as for epoch adjustments.

200.103 Types of calibration and test services.

(a) NBS has developed instrumentation and techniques for realizing standards for the six base units of the International System of Units as agreed on by the General Conference of Weights and Measures. Reference standards have been established not only for these six base units but also for many derived quantities and their multiples and submultiples. Such reference standards, or equivalent working standards, are used to calibrate laboratory and plant standards for other organizations. Accuracy is maintained by stability checks, by comparison with the standards of other national and international laboratories, and by the exploration of alternative techniques as a means of reducing possible systematic error.

(b) Calibrations for many types of instruments and ranges of physical quantities are described in the itemized service schedules of MP 250. On those services for which fees have been established, the fees also are listed in MP 250. In cases where fees have not been fixed, services will be billed on the basis of actual costs incurred. (See Section 200.116 below for details relating to the description of service items and listing of fees.) Changes in services and fees are announced in supplements to MP 250 and in the monthly NBS Technical News Bulletin.*

*For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402.

(c) Upon request, special measurements not listed in MP 250 may be made. These might involve unusual physical quantities, upper or lower extremes of range, higher levels of accuracy, fast response speeds, short durations, broader ranges of associated parameters, or special environmental conditions. Such inquiries should describe clearly the measurement desired. Indication of the scientific or economic basis for the requirement to be satisfied will be helpful in determining future NBS programs. Fees for work accepted will be based on actual costs incurred.

(d) The principal emphasis of the National Bureau of Standards is on those calibrations and other tests requiring such accuracy as can be obtained only by direct comparison with its standards. However, in order to maintain efficient utilization of specialized equipment and skilled personnel, when workload permits NBS may calibrate devices requiring lesser accuracy but suitable for working standards in plant or laboratory.

(e) Other services which may be obtainable include:

(1) Tests of measuring instruments to determine compliance with specifications or claims when the evaluation is critical in national scientific or technical operations and when suitable facilities are not available elsewhere.

(2) Referee tests in important cases when clients are unable to agree upon the method of measurement, the results of tests, or the interpretation of these results, but have agreed in advance in writing to accept and abide by the findings of NBS.

(f) NBS reserves the right to decline any request for services if the work would interfere with other activities deemed by the Director to be of greater importance. In general, measurement services are not provided when widely available from commercial laboratories or for organizations or individuals in foreign countries.

(g) Suggestions will be offered on measurement techniques and on other sources of assistance on calibration or measurement problems when the Bureau's own equipment and personnel are unable to undertake the work. The National Conference of Standards Laboratories issues a Directory of Standards Laboratories in the United States which perform calibration work (obtainable from NCSL Secretariat, c/o National Bureau of Standards, Washington, D. C. 20234). Those which perform testing are listed in the ASTM Directory of Testing Laboratories, Commercial and Institutional. (Directory available from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.) Similar listings appear in buyer's guides for commercial products and in technical journals concerned with physical measurement.

200.104 Consulting and advisory services.

(a) In areas of its special competence, the National Bureau of Standards offers consulting and advisory services on various problems related to measurement, e.g. details of design and construction, operational aspects, unusual or extreme conditions, methods of statistical control of the measurement process, automated acquisition of laboratory data, and data reduction and analysis by computer. Brief consultation may be obtained at no charge; the fee for extended effort will be based on actual costs incurred.

(b) To enhance the competence of standards laboratory personnel, NBS at irregular intervals conducts several group seminars on the precision measurement of specific types of physical quantities, offering the opportunity of laboratory observation and information discussion. A summer course in electromagnetic measurements and standards is conducted periodically by the NBS Radio Standards Laboratory at Boulder, Colorado.

200.105 Standard reference materials.

Often the performance of a device or structure can be evaluated at the user's laboratory by comparing its response to unknown materials with its response to a standardized specimen or a substance of certified composition, properties, or purity. Types of such specimens are listed in several of the detailed fee schedules in MP 260.* For information regarding carefully characterized materials, see Subchapter B of Chapter II, 15 CFR. The Office of Standard Reference Materials in the NBS Institute for Materials Research administers a program to provide many types of well-characterized materials that are needed to calibrate a measurement system or to produce scientific data that can be readily referred to a common base.

200.106 Critically evaluated data.

Data on the physical properties of the thousands of well-defined substances which are commercially available need to be compiled and evaluated to be useful for reference in engineering design. The Office of Standard Reference Data in the NBS Institute for Basic Standards provides two-way communication with a number of governmental and non-governmental data centers throughout the country. Its present compilation and dissemination activities cover seven technical areas—nuclear data, atomic and molecular data, solid state data, thermodynamic and transport data, chemical kinetics, colloid and surface properties, and mechanical properties. Accounts of progress appear in the National Standard Reference Data System News (available upon request from the Office of Standard Reference Data) and in the monthly NBS Technical News Bulletin.*

200.107 Publications.

Changes in services and fees, as published in the supplements to MP 250, appear also in the monthly NBS Technical News Bulletin.* The Bulletin also describes recent results of Bureau staff work, lists currently issued publications and carries sections giving up-to-date detailed information on standards and calibrations, standard reference materials, seminar announcements, conference summaries, and the National Standard Reference Data System. An index to publications by the Bureau authors will be found in Supplements to Miscellaneous Publication 240, Publications of the National Bureau of Standards.* This index covers the publication series of Monographs* and Technical Notes* and includes all papers appearing either in the NBS Journal of Research* or in outside technical journals.

U. S. Government Research and Development Reports, a semi-monthly announcement journal covering over 1000 new documents per issue, is sold by the NBS Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151. Other CFSTI series available on subscription include the USGRDR Index and a Fast Announcement Service which highlights in 57 categories those USGRDR items of particular technological and industrial significance. Any individual item announced is available as photostat or microfiche.

*For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

200.108 Broadcasts.

(a) The NBS Radio Standards Laboratory broadcasts various types of standard frequency and time signals as a service from three radio stations: WWV, WWVH, and WWVB. A fourth station, WWVL, is engaged in an experimental program to evaluate precise time synchronization techniques. NBS Miscellaneous Publication 236, "NBS Standard Frequency and Time Services,"* contains information concerning the broadcasts of such signals from these four stations. WWVH is located at Maui, Hawaii. WWV, WWVL, and WWVB are located at Fort Collins, Colorado. Notices of precisions, accuracies, and adjustments in NBS clocks and radio emissions are published in the Federal Register. Such notices are published also in the Time and Frequency Service Bulletin which is available on request from the NBS Radio Standards Laboratory, Boulder, Colorado 80302.

(b) Broadcasts from WWV are at nominal frequencies of 2.5, 5, 10, 15, 20, and 25 MHz and from WWVH at 2.5, 5, 10, and 15 MHz. Time pulses superimposed on these carrier frequencies occasionally are adjusted in phase and also as to emission rate (by offsetting the carrier frequency from nominal) in accordance with the Universal Time Coordinated (UTC) system,** as recommended by the Bureau International de l'Heure (BIH). The carrier offset currently is minus 300 parts in 10^{10}, giving pulses which occur at intervals slightly longer than one second. With phase adjustment the result approximates UT2 within about 100 ms and therefore is useful in furnishing information about the earth's position on its axis as used to determine the observer's longitude. WWV and WWVH also provide standard musical pitch at 440 hertz, ionospheric propagation condition forecasts, and geophysical alerts. WWV broadcasts Greenwich Mean Time—seconds, minutes, hours, and days of the year—in the code format of the National Aeronautics and Space Administration. For more precise determination of UT2, both WWV and WWVH broadcast in International Morse Code appropriate corrections based on astronomical data from the U. S. Naval Observatory, Washington, D. C.

(c) At WWVL a carrier frequency of 20 kHz is provided and time-shared with others near 20 kHz. Also these carrier frequencies are offset from nominal, hence timing information derived from their phase is also in conformity with the UTC system. Station WWVB broadcasts on the standard radio frequency of 60 kHz without offset, emitting time marker pluses one second apart, as determined by the NBS cesium clock. The phase of these pulses is re-set every few months by 200 ms adjustments as recommended by the Bureau International de l'Heure in order to approximate UT2 within about 100 ms. This is the coordinated system known as Stepped Atomic Time (SAT).

(d) The U. S. Naval Observatory (USNO) also broadcasts standard UTC time and time interval (frequency), using both astronomical and atomic data. It coordinates a number of Navy and Coast Guard stations around the globe and also monitors the NBS broadcasts. Both USNO and NBS monitor broadcasts from selected laboratories in foreign countries and issue periodic comparisons of reference signals.

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*For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

**See G. E. Hudson, Some Characteristics of Commonly Used Time Scales, Proceedings, Institute of Electrical and Electronic Engineers, Vol. 55, No. 6, pp. 815-821, June 1967.

200.109 Request procedure.

(a) A formal purchase order for the calibration or test should be sent before or at the time the instrument or standard is shipped. This should provide clear identification of the apparatus being submitted and give separate instructions for return shipment, mailing of report, and billing. If a customer wishes to minimize the time during which his equipment is out of service, usually he can arrange to delay shipment until the test is scheduled to start (see Section 200.111 below). Requests from Federal agencies, or from State agencies, for calibrations or tests on material to be used on private or Federal contract work, should be accompanied either by purchase order or by letter or document authorizing the cost of the work to be billed to the agency.

(b) The submission of a purchase order for measurement services under this Subchapter shall be understood as constituting an agreement on the part of the customer to be bound by the restrictions on the use of results as set forth in Section 200.114 below. Acceptance of purchase orders does not imply acceptance of any provisions set forth in the order contrary to the policy, practice, or regulations of the National Bureau of Standards or the U. S. Government. (A statement to the effect that the National Bureau of Standards is an agency of the U. S. Government should satisfy other government agencies with regard to compliance with government regulations and executive orders.)

(c) A test number will be assigned by the Bureau to each instrument or group of similar instruments or standards when the order is accepted. This test number should be referred to in all subsequent communications. Also, each instrument in a group must be uniquely identified, usually by the manufacturer's name and instrument serial number. When the serial number is lacking, an alternative identifying mark should be provided. If none is found, the Bureau will mark the piece with an NBS identification number. If the apparatus submitted has been calibrated previously by the Bureau, the serial number or identifying mark should be given on the new order so that a continuing record of stability history can be established.

(d) Inquiries for measurement services related to electrical standards in the radio-frequency region (above 30 kHz) or to frequency and time standards should be directed to:

Coordinator, Calibration Services
Radio Standards Laboratory
National Bureau of Standards
Boulder, Colorado 80302

(e) Inquiries for measurement services other than those noted in paragraph (d) of this Section should be directed to the following:

Test Administration Unit
National Bureau of Standards
Washington, D. C. 20234

200.110 Shipping, insurance, and risk of loss.

(a) Shipment of apparatus to NBS for calibration or other test should be made only after the customer has accepted the estimate of cost and the tentative scheduling. Repairs and adjustments on apparatus submitted should be attended to by the owner since NBS will not undertake them except by special arrangement. Apparatus not in good condition will not be calibrated. If defects are found after calibration has begun, the effort may be terminated, a report issued summarizing such information as has been found, and a fee charged in accordance with the amount of work done.

(b) The customer should pack apparatus sent to NBS so as to minimize the likelihood of damage in shipment and handling. Suggestions on packing and shipping are made in some Sections of MP 250. In every case, the sender should consider the nature of the apparatus, pack it accordingly, and clearly label shipments containing fragile instruments or materials such as glass. The use of "security express" should be considered in shipping delicate instruments.

(c) To minimize damage during shipment resulting from inadequate packing, the use of strong reusable containers is recommended. As an aid in preventing loss of such containers, the customer's name should be legibly and permanently marked on the outside. In order to prolong the container's use, the notation REUSABLE CONTAINER, DO NOT DESTROY should be marked on the outside.

(d) Shipping and insurance coverage instructions should be clearly and legibly shown on the purchase order for the calibration or test. The customer must pay shipping charges to and from NBS; shipments from NBS will be made collect. The method of return transportation should be stated, and it is recommended that return shipments be insured, since NBS will not assume liability for their loss or damage. For long-distance shipping it is found that air express and air freight provide an advantage in reduction of time in transit. If return shipment by parcel post is requested or is a suitable mode of transportation, shipments will be prepaid by NBS, but without covering insurance. When no shipping or insurance instructions are furnished, return shipment will be made by common carrier collect and uninsured.

(e) NBS will not be responsible for the risk of loss or damage to any item during shipment to or from the Bureau. Any arrangements for insurance covering this risk must be made by the customer. Return shipment will be made by the Bureau as indicated in paragraph (d) of this section. The purchase order should always show the value of the equipment and if transit insurance is carried by the customer this fact should be stated.

(f) The risk of loss or damage in handling or testing of any item by NBS must be assumed by the customer, except when it is determined by the Bureau that such loss or damage was occasioned solely by the negligence of Bureau personnel.

(g) When a test number has been assigned prior to shipment to NBS, this number should be clearly marked on the shipping container. When a test number has not been assigned, an invoice, copy of the purchase order, or letter should be enclosed in the shipment to insure proper identification. The original purchase order should be forwarded as appropriate to:

Test Administration Unit
National Bureau of Standards
Washington, D. C. 20234

or to

Coordinator, Calibration Services
Radio Standards Laboratory
National Bureau of Standards
Boulder, Colorado 80302

(h) The calibrations listed in MP 250 are performed at these locations: Boulder, Colorado; Gaithersburg, Maryland; and Washington, D.C.

(1) Calibrations of electrical standards and materials in the radio-frequency region (above 30 kHz) and all frequency and time calibrations are performed at Boulder, Colorado and shipments should be addressed to:

Coordinator, Calibration Services
Radio Standards Laboratory
National Bureau of Standards
Boulder, Colorado 80302

If apparatus for radio frequency is to be given incidental low-frequency calibration also (below 30 kHz), this may be done at Boulder but if a complete range of low-frequency calibrations are needed, the instrument should be sent to:

National Bureau of Standards
Route 70S and Quince Orchard Road
Gaithersburg, Maryland 20760

(2) Calibrations listed in MP 250 other than those noted in paragraph (1) above, of this Section, are performed in the Bureau's laboratories at either Githersburg, Maryland or Washington, D.C. For shipments which are heavy (in excess of 100 lbs.) or bulky (a combined girth in excess of 27 cu. ft.), request a shipping address from:

Test Administration Unit
National Bureau of Standards
Washington, D. C. 20234

Items other than heavy or bulky shipments that are sent by common carrier should be addressed to:

National Bureau of Standards
Route 70S and Quince Orchard Road
Gaithersburg, Maryland 20760

200.111 Priorities and time of completion.

Scheduled work assignments for calibrations and other tests generally will be made in the order in which confirmed requests are received. However, government work may be given priority. On the regular services, the workload usually is such that the turn-around interval, between the date a customer's apparatus is received and the date it is prepared for return shipment, will be not more than 45 days. Some types of instruments may require considerably longer, particularly if their abnormal behavior requires re-runs to check reliability. Others can be calibrated and returned within 10 days. Special tests, such as the "z" items listed in MP 250 require individual scheduling. The customer who can spare his instrument for only a short time usually can arrange by letter or phone call for shipping it to the Bureau just as his assigned starting date approaches. A notice will be sent acknowledging receipt of the customer's standard and/or purchase order. If both a confirmed purchase order (or equivalent) and the apparatus have been received, estimates of a completion date and a calibration fee will be sent upon request.

200.112 Witnessing of operations.

The Bureau welcomes scientists and engineers who may wish to visit its laboratories and discuss its methods. Ordinarily visitors will not be permitted to witness the actual carrying out of highly precise measurements because their presence introduces distraction that may lead to errors or delays. This policy may be waived in those cases where the visitor can be of service in setting up apparatus of a new or unusual nature, in the case of referee tests, or in other cases in which the legal validity of the result may require the presence of duly authorized witnesses.

200.113 Reports.

(a) Results of calibrations and other tests are issued to the customer as formal reports entitled, "National Bureau of Standards Report of Calibration," "National Bureau of Standards Report of Test," or "National Bureau of Standards Report of Analysis," as appropriate. Copies are not supplied to other parties. Whenever formal certification is required by law, or to meet special conditions adjudged by the National Bureau of Standards to warrant it, a letter will be provided certifying that the particular item was received and calibrated or tested, and identifying the report containing the results.

(b) NBS reports of calibration generally include in sentence form a statement of the uncertainty attached to the numerical values reported. Limits of uncertainty usually comprise (1) an estimate of systematic error, plus (2) a value of imprecision.

(1) Often the systematic error estimate is based on experience or judgment. Sometimes it is an explicit combination of a number of elemental systematic errors. Sometimes the value can be checked by using two completely different physical phenomena, types of standard, or measurement techniques.

(2) Imprecision is preferably expressed as three times the standard deviation of a single determination or three times the standard error of the arithmetic mean of n determinations, either being a canonical value for the measurement process based on considerable recent experience. When extended experience is lacking, the terms "computed standard deviation" or "computed standard error" should be used.

(3) A laboratory using NBS results to estimate the uncertainty attached to its own work may equate its own systematic error to the NBS quoted limit of uncertainty, as a minimum. The imprecision of its own work is best evaluated by calibration records extended over considerable periods of time, with repetition of its specified calibration procedure and assurance that its measurement process is in statistical control. For further information see:

(i) Youden, W. J., Uncertainties in Calibration. IRE Trans., Vol. I-11, Nos. 3 and 4, p. 133 (Dec. 1962).

(ii) Eisenhart, Churchill, Realistic Evaluation of the Precision and Accuracy of Instrument Calibration Systems. NBS J. Res., Vol. 67C, No. 2, p. 161 (April-June 1962).

(iii) Natrella, M. G., Experimental Statistics. NBS Handbook 91, Ch. 23 (Aug. 1, 1963).

(iv) Wildhack, W. A.; Mason, H. L.; and Powell, R. C.; Accuracy in Measurements and Calibrations, 1965. NBS Technical Note No. 262. (Shows the general status of NBS accuracy limits as of June 1965.)

(v) Wildhack, W. A.; Mason, H. L.; and Powers, R. S., Jr.; Accuracy Charts for RF Measurements. Proc. IEEE, Vol. 55, No. 6, pp. 1056-1063 (June 1967).

(vi) Eisenhart, Churchill and Ku, H. H., Expression of the Uncertainty of Final Results and a Tabular Guide to Commonly Used Terms and Expressions. In press.

200.114 Use of results or reports.

(a) As the national standards laboratory of the United States, NBS maintains and establishes the primary standards from which measurements in science and industry ultimately derive. It is sometimes desirable therefore for manufacturers or users of measurement standards to make appropriate reference to the relationship of their calibrations to NBS calibrations. The following considerations must be borne in mind and shall be understood as constituting an agreement on the part of the NBS customer to be bound thereby in making reference to NBS calibration and test reports.

(b) The results of calibrations and tests performed by NBS are intended solely for the use of the organization requesting them and only apply to a particular device or specimen at the time of its test. The results shall not be used to indicate or imply that they are applicable to other similar items. In addition, such results must not be used to indicate or imply that NBS approves, recommends, or endorses the manufacturer, the supplier, or the user of such devices or specimens, or that NBS in any way "guarantees" the later performance of items after calibration or test.

(c) NBS declares it to be in the national interest that the Bureau maintain an impartial position with respect to any commercial product. Advertising the findings on a single instrument could be misinterpreted as an indication of performance of other instruments of identical or similar type. There will be no objection, however, to a statement by a manufacturer that his primary standards have been periodically calibrated by NBS, if actually this is the case, or that his customer might arrange to have NBS calibrate the item purchased from him.

(d) NBS does not approve, recommend, or endorse any proprietary product or proprietary material. No reference shall be made to the Bureau or to reports or results furnished by NBS in any advertising or sales promotion which would indicate or imply that NBS approves, recommends, or endorses any proprietary product or proprietary material, or which has as its purpose an intent to cause directly or indirectly the advertised product to be used or purchased because of NBS test reports or results.

In its own activities as a scientific institution, the NBS uses many different materials, equipments, and services. This does not imply that it has given them a preferential position or a formal endorsement. Therefore, NBS discourages references, either in advertising or in the scientific literature, which identify it as a user of any proprietary product, material, or service. Occasionally, effective communication of results by NBS to the scientific community requires that a proprietary instrument, product, or material be identified in an NBS publication. Such reference to a proprietary item does not constitute endorsement and should not be used in any way apart from the context of the NBS publication without the express written consent of the Bureau.

200.115 Fees and bills.

(a) In accordance with 15 U.S.C. 271-278e, fees are charged for all measurement services performed by the National Bureau of Standards unless waived by the Director when deemed to be in the interest of the government. The above-mentioned statutes authorize the Secretary of Commerce to make appropriate regulations from time to time regarding the payment of fees, the limits of tolerance on standards submitted for verification, and related matters. See Section 200.116 below for information as to fees.

(b) The minimum fee for any service request accepted by the Bureau is $10, unless otherwise indicated in MP 250. If an apparatus is returned without testing, a minimum charge of $10 may be made to cover handling. Charges commensurate with the work performed will be assessed for calibrations which cannot be completed because of faulty operation of the customer's device. Fees for calibrations or tests include the cost of preparation of an NBS report. All checks should be made payable to NBS, Department of Commerce.

200.116 Description of services and list of fees, incorporation by reference.

(a) NBS Miscellaneous Publication 250 , "Calibration and Test Services of the National Bureau of Standards," is hereby incorporated by reference, pursuant to 5 U.S.C. 552(a)(1) and 1 CFR Part 20. MP 250 states the authority under which NBS performs various types of measurement services, including calibrations and tests, and charges fees therefor, states the general conditions under which the public may secure such services, describes these services in considerable detail, lists the fees to be charged, and sets out the instructions for requesting them.

(b) MP 250 is available at the following places:

(1) Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

(2) Office of Technical Information and Publications, National Bureau of Standards, Washington, D. C. 20234.

(3) Field offices of the Office of Field Services, Department of Commerce.

(4) Federal Depository Libraries.

(c) Revisions, amendments, revocations, deletions, recodifications, redesignations, and corrections to MP 250 will be issued from time to time by the National Bureau of Standards, Washington, D.C. in the form of replacement pages or insert sheets; a postcard is provided in MP 250 for requesting copies. NBS will maintain an official historic file of MP 250 and of replacement pages and insert sheets.

(d) Further information concerning policies, procedures, services, and fees may be obtained by writing the Office of Technical Information and Publications, National Bureau of Standards, Washington, D.C. 20234.

USCOMM-NBS-DC

CALIBRATION AND TEST SERVICES OF THE

NATIONAL BUREAU OF STANDARDS

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

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Change 29

X- and gamma-ray instruments: This insert contains revised versions of Schedules 204.501 and 204.502. The old text, appearing on pages 95-99 of MP 250, 1965 edition, should be deleted and the present insert placed after page 94.

Fees have been revised upward to yield full recovery of the cost of providing the services. The old fees, which appear on page 5 of Insert 13 (June 30, 1967), should be deleted and the new fees written in beside them. The other principal changes are the following:

204.501e: The calibration range has been extended upward to 100 roentgens.

204.501g: This is a new item, providing for calibration of guard-ring type chambers.

204.502: The wording of items in this schedule have been modified for greater clarity.

The revised text of Schedules 204.501 and 204.502 follows:

204.501 X- and gamma-ray measuring instruments in exposure units (roentgens).

X-ray exposure-indicating instruments are calibrated to within ±2 percent by a substitution method in an x-ray beam at a point where the exposure rate (R/min) has been determined by means of a standard free-air ionization chamber. In order to provide instrument calibration over a wide spectrum of x-ray energies, many combinations of kilovoltage and filtration are available. These are given in the tables below. The calibration technique chosen should be appropriate to the particular instrument submitted.

*Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of the insert are available from the NBS Office of Technical Information and Publications.

Lightly filtered x rays

Technique	kvcp	Approx. inherent filter	Added filter	Distance	Approx. first half-value layer	Homogeneity coefficient (1st HVL/2d HVL)	Instrument range from zero		Exposure rate	
							min.	max.	min.	max.
		mm Be	*mm Al*	*cm*	*mm Al*		*R*	*R*	*R/min*	*R/min*
LFB	10	1.00	0	25	0.024	0.75	50	500	10	100
LFC	15	1.00	0	25	0.035	0.62	100	1000	25	250
LFD 50	20	0.25	0	50	0.06	0.42	100	500	50	200
LFD 70	20	0.25	0	70	0.07		50	100	20	80
LFD 100	20	0.25	0	100	0.08		25	50	7	30
LFE	20	0.25	0.5	50	0.20	0.68	10	100	2	8
LFG	30	0.25	0.5	50	0.33	0.67	25	250	5	20
LFI	50	0.25	1.0	50	0.90	0.68	25	250	6	25
LFK	75	0.25	1.5	50	1.6	0.66	25	250	10	22
LFM	100	0.25	2.0	50	2.5	0.63	25	250	14	25

Moderately filtered x rays

Technique	kvcp	Approx. inherent filter	Added filter		Approx. first half-value layer		Homogeneity coefficient (1st HVL/2d HVL)	Instrument range from zero		Exposure rate	
			Cu	Al	Cu	Al		min.	max.	min.	max.
		mm Al	*mm*	*mm*	*mm*	*mm*		*R*	*R*	*R/min*	*R/min*
MFB	60	1.5	0	0		1.6$_4$	0.67	5	100	0.4	3.0
MFC	60	1.5	0	2.5	0.09	2.7$_9$	0.77	5	100	0.4	2.5
MFE	75	1.5	0	2.5	0.11	3.4$_1$	0.73	5	100	0.4	4.0
MFG	100	1.5	0	3.5	0.20	5.0$_8$	0.73	5	100	0.9	6.0
MFI	150	1.5	0.25	3.5	0.66	10.1	0.87	5	100	1.0	8.0
MFK	200	1.5	0.5	3.5	1.2$_6$	13.2	0.92	10	250	2.0	13.0
MFM	250	1.5	1.0	3.5	2.1$_7$	16.2	0.94	10	250	2.5	17.0
MFO	250	1.5	3.2	3.5	3.2$_0$	18.4	0.98	10	250	1.3	10.0

Heavily filtered x rays *

Technique	kvcp	Approx. inherent filter	Added filter				Approximate			Instrument range from zero		Exposure rate	
			Pb	Sn	Cu	Al	Effective energy	HVL	HVL	min.	max.	min.	max.
		mm Al	*mm*	*mm*	*mm*	*mm*	*kev*	*mm* Cu	*mm* Al	*R*	*R*	*R/min*	*R/min*
HFC	50	1.5	0.12	0	0	2.5	40	0.16	4.4	0.1	1	0.02	0.09
HFE	100	1.5	0.53	0	0	2.5	70	0.72	11.2	0.1	5	0.05	0.27
HFG	150	1.5	0	1.5	4.0	2.5	120	2.4	16.8	0.1	5	0.04	0.22
HFI	200	1.5	0.7	4.0	0.6	2.5	170	4.1	19.5	0.1	5	0.03	0.21
HFK	250	1.5	2.7	1.0	0.6	2.5	215	5.4	21.5	0.1	5	0.03	0.21

Item	Description	Fee
204.501a	Calibration of one x-ray exposure or exposure-rate indicating instrument of one range for each technique or setup listed under "LIGHTLY FILTERED X RAYS" or "MODERATELY FILTERED X RAYS"----------	$68.
204.501b	Calibration of each additional x-ray exposure or exposure-rate indicating instrument of the same range by the same technique as selected under 204.501a and not requiring a change in setup----------	26.
204.501c	Calibration of one x-ray exposure or exposure-rate indicating instrument for each technique listed under "HEAVILY FILTERED X RAYS"----------	87.
204.501d	Calibration of each additional x-ray exposure or exposure-rate indicating instrument of the same range by the same technique as selected under 204.501c, not requiring a change in setup----------	31.
	Instrument calibrations for cobalt 60 and cesium 137 gamma radiation are performed by exposure of the instrument to the gamma rays at points in the collimated beams which have been calibrated to within about ±2 percent by means of carbon wall cavity ionization chambers. The exposure rates at the time of the measurements are computed from the original calibration data and appropriate decay corrections. Ionization chambers submitted for calibration should have sufficient wall thickness for electronic equilibrium for the gamma-ray energy selected.	
204.501e	Calibration of one instrument for gamma rays when no stem effect is considered:	
	(1) Exposure-rate indicating instrument for each exposure-rate between 0.01 and 15 R/min; or	
	(2) Exposure-indicating instruments with full scale readings from 0.1 to 100 R----------	62.
	When the chamber must be calibrated with the stem exposed and protected, the fee will be the sum of fees for 204.501e and f.	
204.501f	Calibration of each additional instrument having the same exposure or exposure-rate range as under 204.501e, when the instruments are submitted at the same time, and when no stem effect is considered----------	26.
	When the chamber must be calibrated with the stem exposed and protected the fee will be the sum of fees for 204.501e and f.	
	Guard-ring type cavity ionization chambers independent of electrometers may be calibrated for x and gamma rays in terms of amperes per roentgen per minute. Calibrations are performed for both positive and negative collection	

potentials. The ratio of ionization currents for full- and half-voltage collection potentials and the exposure rate used in the calibration will be stated.

204.501g	Calibration of one guard-ring-type cavity ionization chamber for each x-ray technique or gamma-ray energy listed----------	$110.

204.501z Calibration of one x- or gamma-ray exposure or exposure-rate indicating instrument:

(1) Calibrations of higher accuracy or greater range than that routinely furnished; or

(2) Calibrations on x rays of energies other than those listed under 204.501a, c, or e; or

(3) Calibrations requiring a special setup or special procedure.

Only a limited number of special calibrations can be undertaken and requests for such should be submitted with full details for consideration. For these and other special measurements not covered by the above schedule, fees have not been fixed and charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual cost.

204.502 Gamma-ray sources.

Radioactive preparations submitted to the Bureau for test are subject to the following conditions:

(a) Financial responsibility: The Bureau assumes no responsibility for loss or damage to radioactive preparations while in its possession. The risk should be covered by insurance.

(b) Period of measurement: Approximately 10 days are required for measurement of these radioactive preparations.

(c) Preparation of specimens: Radioactive preparations submitted for test must be sealed carefully so that there can be no escape of any radioactive material, including any gaseous decay products. The preparations, shielding, and packaging must be free of contamination. Contaminated or leaking preparations cannot be measured and may cause considerable loss of time and damage to laboratory facilities. Preparations must have been sealed for a sufficient time to be substantially in radioactive equilibrium with their decay products when these contribute to the gamma emission (at least 30 days for radium).

(d) Packaging for shipment: Regulations of the Interstate Commerce Commission regarding the shipment of radioactive substances by rail must be complied with. These regulations are enforceable by law and prospective shippers of these substances need to be familiar with them. Copies of the regulations can be obtained from the Interstate Commerce Commission, Washington, DC 20423.

(e) Possession of licensed material: In submitting specimens of cobalt 60 or other licensed source material (except radium, which is not

licensed) for calibration, it will be necessary for the submitter to certify that he is duly authorized to possess the material under license by the USAEC, except in the case of individuals residing in a State which has entered into agreement with the USAEC, in which case State regulations are applicable. This certification may be by letter, by a suitable statement on the purchase order covering the calibration fee, or by a clear copy of the submitter's Possession License for the source material.

(f) Type of measurements:

(1) Radium is calibrated in terms of milligrams of equivalent radium content measured relative to the National Radium Standard through comparison of the gamma radiation from the specimen and the standard. Where the details of encapsulation of the specimen are known, corrections can be made to obtain milligrams of radium content. Cobalt 60 is calibrated in terms of exposure rate, milliroentgens per hour at one meter, based on comparison with derived standards of cobalt 60.

(2) Postal regulations prohibit mailing radioactive materials which require a caution label under ICC regulations. This effectively prohibits placing radioactive preparations in the mail.

Item	Description	Fee
204.502a	Gamma-ray measurement of one radioactive preparation: 0.5 to 15 mg radium or encapsulated cobalt 60 having exposure rates from 0.5 to 15 mRhm (milliroentgens per hour at one meter). Measurement to ±0.7 percent for radium and to ±3 percent for cobalt 60----------	$31.
204.502b	Gamma-ray measurement of one radioactive preparation: 15+ to 100 mg radium or encapsulated cobalt 60 having exposure rates from 15+ to 100 mRhm (milliroentgens per hour at one meter). Measurement to ±0.7 percent for radium and to ±3 percent for cobalt 60----------	44.
204.502c	Gamma-ray measurement of one radioactive preparation: 100+ to 250 mg radium or encapsulated cobalt 60 having exposure rates from 100+ to 200 mRhm (milliroentgens per hour at one meter). Measurement to ±0.7 percent for radium and to ±3 percent for cobalt 60----------	63.
204.502d	For measurements in groups not exceeding 10 preparations, double the fee for preparations of same content as the total content of the group.	
204.502e	For handling and examination of a shipment containing contaminated or leaking preparations, the fee will be the same as for measurements of a preparation having a content equal to the total nominal radioactive content of the shipment.	
204.502z	For special measurements not covered by the above schedule, fees have not been fixed and charges will be made for actual costs incurred. As only a limited number of special tests can be carried out, prior arrangements must be made, including submission of full details concerning the required test. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual cost.	

U. S. Department of Commerce
National Bureau of Standards

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CALIBRATION AND TEST SERVICES OF THE

NATIONAL BUREAU OF STANDARDS

Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

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Change 30

Electricity, Microwave Region: Several new services, all pertaining to waveguide WR284 (2.60-3.95 GHz), are now offered:

Item 201.920a-6 is added to Section 201.920--Waveguide reflectors (mismatches), reflection coefficient magnitude. The most recent version of this section appears on page 20 of Insert 5 (Apr. 3, 1967), and the following line should be written in the space between items 201.920a-5 and 201.920a-20 of the table there given:

201.920a-6	WR284 (2.60-3.95 GHz)	(*)

Three new items are added to Section 201.910, as shown in the table below. To enter these changes, the present sheet should be inserted just ahead of page 19 of Insert 5 (Apr. 3, 1967).

Section 201.910 Continuous-wave, low-level power measurements of waveguide bolometer units and bolometer-coupler units.

Item	Description	Fee
201. 910a-7	Determination of effective efficiency of bolometer unit, at a single frequency, of the following waveguide size terminated with a standard waveguide connector: WR284 (2.60-3.95 GHz)----------	(**)
201.910b-7	Determination of calibration factor of bolometer unit, at a single frequency, of the following waveguide size terminated with a standard waveguide connector: WR284 (2.60-3.95 GHz)----------	(**)
201.910c-7	Determination of calibration factor of bolometer-coupler unit, at a single frequency, of the following waveguide size terminated with a standard waveguide connector: WR284 (2.60-3.95 GHz)----------	(**)

(**) As fixed prices have not been established for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

* Changes should be made immediately in your copy of NBS Misc. Publ. 250, 1965 Edition. Additional copies of the insert are available from Office of Technical Information and Publications, National Bureau of Standards, Washington, D. C. 20234.

CALIBRATION AND TEST SERVICES OF THE

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Notice of Change to NBS Misc. Publ. 250, 1965 Edition*

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Change 31

Electricity, Microwave Region: A series of services for nonreflecting waveguide ports has been added, as described in the new Section 201.921, the complete text of which is given below. To enter this change, the present sheet (Insert 20) should be inserted just ahead of page 21 of Insert 5 (Apr. 3, 1967).

Section 201.921 Nonreflecting waveguide ports (including matched loads), with reflection coefficient magnitude of nearly zero.

(a) Evaluations are made on nonreflecting waveguide ports, including matched loads.

(b) Nonreflecting waveguide ports must be fitted with a standard type of waveguide flange. The face of the flange should be machined flat and smooth and should not contain protusions or indentations. The connecting holes of the flange should be symmetrically and accurately aligned to the rectangular waveguide opening. The back of the flange which makes contact with the connecting bolts should be nominally flat and free of soft materials, including paint.

Item	Description	Fee
	Evaluation of nonreflecting waveguide port at a single frequency of the following waveguide sizes terminated with standard waveguide connectors:	
201.921a-1	WR90 (8.20-12.4 GHz) ----------	(**)
201.921a-2	WR62 (12.4-18.0 GHz) ----------	(**)
201.921a-3	WR137 (5.85-8.20 GHz) ----------	(**)
201.921a-4	WR112 (7.05-10.0 GHz) ----------	(**)
201.921a-5	WR187 (3.95-5.85 GHz) ----------	(**)
201.921a-6	WR284 (2.60-3.95 GHz) ----------	(**)
201.921a-20	Evaluation of each additional nonreflecting waveguide port at the same frequency as for 201.921a-1 to 201.921a-6 ----------	(**)

(**) As fixed prices have not been established for these services, charges will be made for actual costs incurred. Upon request, estimates will be furnished for specific tasks which should provide a close approximation of actual costs.

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